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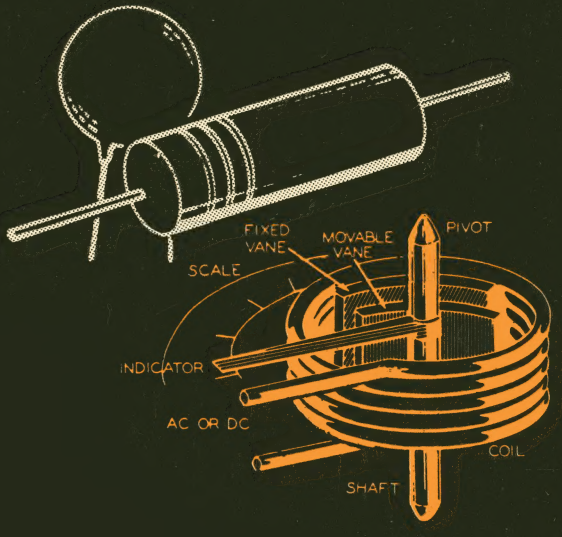

ELECTRONIC
COMPONENTS
ENCYCLOPEDIA

by
Farl J. Waters

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PREFACE

The field of electronics is constantly being expanded. With this expansion, new components are making their way into the industry and finally to the public. Engineers and physicists are constantly creating new components leading to more efficient and compact systems.

It is almost impossible, therefore, for one person to keep abreast of the electronic field and to acquire complete and updated knowledge of all existing and upcoming components on the market. Sometimes an individual who wants to identify a new component will have to purchase an entire book to obtain the material he requires.

The intent of this encyclopedia therefore, is to provide information encompassing electronic components. Whether you are a beginner in the field of electronics, a student, or technician, you will find this an authoritative and easy to understand reference. Many illustrations are included to clarify the information, as well as to give a first-hand look for future identification or reference. Where included, the illustrations have under them clear and concise captions which can be immediately associated with the proper definition.

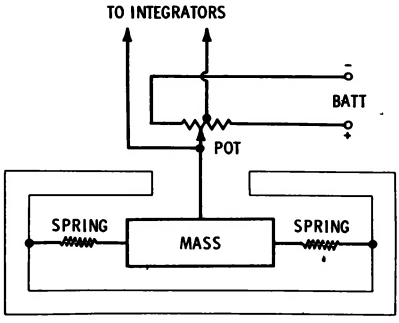
Every entry is listed in an easy-to-follow format. For example, the word "transformer" is followed first by a formal definition and then ten different transformer types in alphabetical order according to their purpose or name. Since some components can be referred to by several different names, many cross-references have been included to further aid the reader in obtaining the information he desires.

FARL J. WATERS

A

ACCELEROMETER

An electromechanical transducer used in determining the change in velocity of a body. *Also See Transducer (Telemetry).*



Accelerometer.

AF SIGNAL GENERATOR

See Signal Generator (AF)

AIR-VARIABLE CAPACITOR

See Capacitor (Air-Variable)

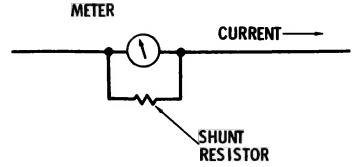
ALKALINE BATTERY

See Battery (Alkaline)

AMMETER

A meter used for the measurement of current.

Ammeters measure current by having the magnetic field developed by the current react with a fixed magnetic field. The resulting torque turns a pointer by an angle relative to the rate of current flow. For measuring direct current (dc), D'Arsonval and permanent-magnet



Basic ammeter circuit with shunt.

ammeters are used. One type of ammeter, a two coil dynamometer, finds usage in measuring direct current and low-frequency, alternating current while the iron-vane, hot-wire, and thermocouple ammeters are only used in ac circuits. Higher-frequency, alternating currents require use of rectifiers, thermocouples, or Hall-effect converters. Ammeters may be calibrated to read average, peak, or rms (effective) values. The range of an ammeter may be extended by using a shunt to pass a portion of the current around the meter. *Also see Meter (D'Arsonval), Meter (Iron-Vane), Meter (Thermocouple), Meter (Rectifier), Meter (Dynamometer).*

AMPLIFIER (INTEGRATED CIRCUIT)

See Integrated Circuit

AMPLIFIER (MAGNETIC)

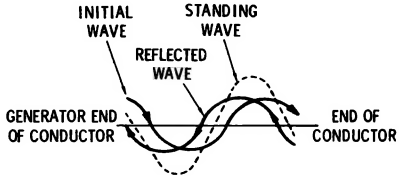
See Magnetic Amplifier

AMPLIFIER (MODULE)

See Module

ANTENNA

A vertically or horizontally mounted conductor radiating or intercepting electromagnetic and electrostatic radiations. Such radiations are the result of standing current and voltage waves on the transmitting antenna. Inversely, at the receiving antenna, the radiations produce standing current and voltage waves. The initial current wave



Initial, reflected, and standing waves on an antenna.

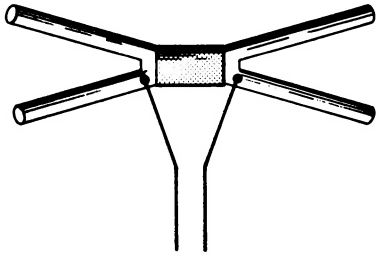
travels along the antenna conductor, the reflected wave travels in the opposite direction, and therefore a resulting standing wave exists. The radiations will be at right angles to the length of the antenna conductor. Electrostatic radiations from an antenna diminish rather quickly and do not exist far from the transmitting antenna. However electromagnetic waves travel great distances.

ANTENNA (BOW-TIE)

A small conical antenna constructed of wire or perforated metal. The bow-tie antenna is used as either an indoor or an outdoor antenna for the reception of uhf television. *Also see Antenna (Conical).*

ANTENNA (CONICAL)

A form of half-wave dipole originally using cone-shaped radiating conductors. Presently used for the reception of television signals, the conical antenna has taken the form

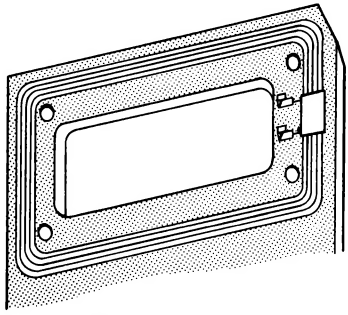


Conical antenna.

of two V-shaped rods. Such an antenna would have a wide frequency response and an impedance of 300 ohms, which matches the impedance of a twin-lead transmission line and receiver input. *Also see Antenna (Half-Wave Dipole).*

ANTENNA (FLAT-LOOP)

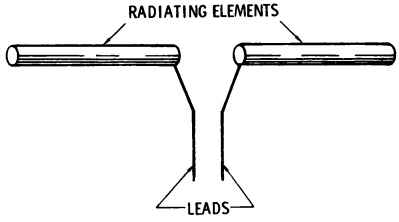
An antenna used in many older table model and portable radios. A flat-loop antenna consists of several turns of insulated wire on a fiberboard form. Usually mounted against the receiver's cabinet back, the flat-loop antenna is adequate for the reception of most standard broadcast stations. Modern receivers have replaced the flat-loop antenna with the loopstick antenna.



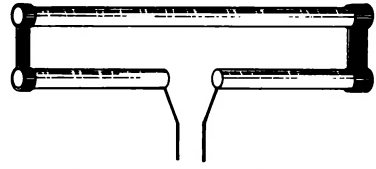
Flat-loop antenna.

ANTENNA (HALF-WAVE DIPOLE)

The half-wave dipole antenna can be described as being two quarter-wave conductors separated so that each conductor extends in opposite directions. Therefore, the half-wave dipole is one-half wave long with a half-wavelength standing wave. In a vertical position the half-wave dipole radiates equally in all directions. The impedance of a half-wave dipole is normally 72 or 75 ohms. Many other antenna types or antenna arrays use the half-wave dipole in one form or another. Receiving and transmitting antennas for television and fm broadcasting are half-wave dipoles or 300-ohm, folded half-wave dipoles.



Half-wave dipole.



Folded half-wave dipole.

ANTENNA (LONG-WIRE)

An antenna having a length greater than one wavelength. Used primarily for the reception and transmission of radio signals over great distances, the long-wire antenna is becoming antiquated by use of higher frequencies and satellite relays.

ANTENNA (LOOPSTICK)

See Loopstick Antenna

ANTENNA (PARASITIC)

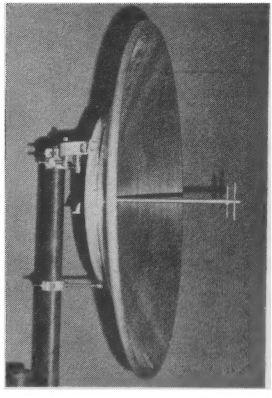
An antenna receiving its excitation from a directly fed antenna. The parasitic antenna, or parasitic element, has no direct electrical connection with another antenna, transmitter, or receiver but is excited by radiations from another antenna. The parasitic antenna does not absorb the energy of these excitations but reradiates the waves with a 180° phase shift. Such reradiated waves act to increase or decrease the original waves. *Also see Antenna (Yagi).*

ANTENNA (QUARTER-WAVELENGTH)

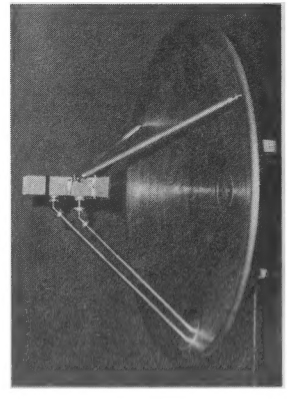
An antenna much like the half-wave dipole, but having only one-half its length and being fed from the end. Commonly used in the vertical position, the quarter wavelength antenna finds considerable use in mobile communications.

ANTENNA (REFLECTOR)

An antenna mounted within a parabolic or corner-shaped reflector to increase its directivity. The radiating element, located within the reflector, may be a half-wave dipole or a hook-shaped section of waveguide. Waves striking the reflector are reflected back in the opposite direction to give a highly directive radiation pattern. The parabolic reflector is capable of concentrating the radiations, in both the horizontal and vertical, much better than the corner reflector. Since the dimensions of the radiating elements and reflectors are in inverse proportion to the frequency, the corner or parabolic reflector is seldom used with frequencies below 300 MHz (one meter wavelength).

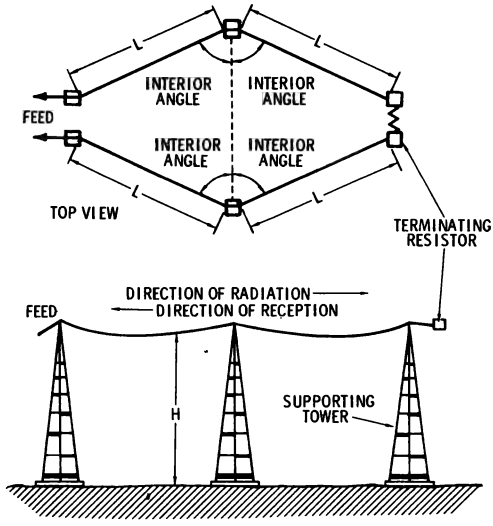


Dipole feed system.



Waveguide feed system.

Parabolic reflector.



Rhombic antenna.

ANTENNA (RHOMBIC)

A broad-band unidirectional antenna with a high gain. In the vhf band it has a very large size but in the uhf band its size comes down toward a more practical requirement. Radiators compose the sides of a rhombus with one end normally terminated into a resistance.

ANTENNA (SLOTTED)

A transmitting antenna used for uhf television channels 14 to 83 (470 to 890 MHz). The slotted antenna has the appearance of a tube having a number of slots cut into its surface. The electrical waves are brought to each slot by a transmission line (waveguide) and coupled into this tube. However, the high rf resistance and impedance of this solid steel tube will cause the currents to concentrate at the slot edges. Standing waves and radiations are developed along the edges of each slot just as though the slot were a radiating half-wave dipole antenna.

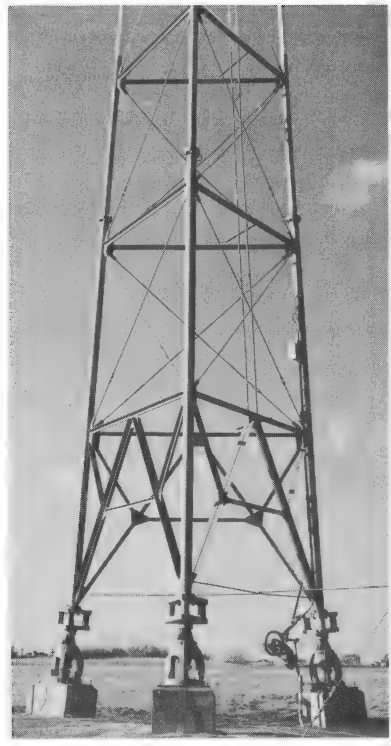
ANTENNA (STACKED)

Two or more half-wave dipole antennas or Yagi combinations spaced vertically to concentrate the horizontal radiations. Since the half-wave dipole antenna has as much of its radiation, or receiving power, in the vertical direction as

in the horizontal, a large portion of its radiation is lost. By stacking such antennas, the vertical radiations can be considerably reduced while those radiations, or received waves, in the horizontal plane are increased. Television and fm broadcast stations increase their effective radiated power and reception areas by using as many as 12 antenna elements in a stacked array. For example, a fm station with a 10,000 watt transmitter uses a stack of three antennas to obtain an effective radiated power of 31,000 watts. In the fringe areas of television reception, stacks of two or more antennas are often used to receive an adequate signal.

ANTENNA (TOWER)

A nondirectional antenna used by standard broadcast stations. This antenna is constructed as a guyed or self-supporting steel tower ranging from 175 feet to 900 feet in height, which is equivalent to heights ranging from 0.25 to 0.56 wavelength. As far as practical, the radiating towers are constructed with heights that will reduce the sky wave (lost radiation). With the tower insulated from the ground, the rf current is fed directly into the base of the tower structure. To obtain a directional radiation pattern, an array of two or more towers is used with various spacing and phasing.



Tower antenna.

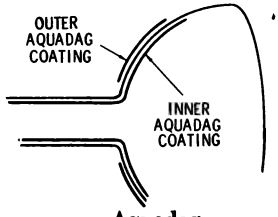
ANTENNA (YAGI)

An antenna array consisting of an active half-wave dipole and a number of parasitic elements. One element acts as a reflector and the others serve as directors to pull additional signal strength toward the half-wave dipole. The combination becomes extremely directional with a very high gain. The Yagi antenna may also be used in stacked arrays for additional gain. These characteristics make the Yagi an-

tenna excellent for use in television fringe areas.

AQUADAG

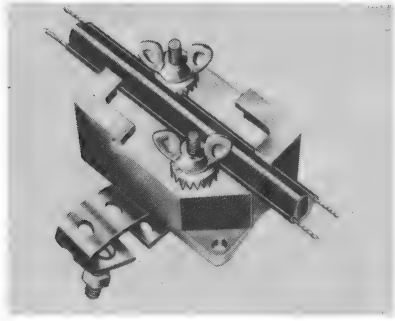
A conductive graphite coating serving as an electrostatic shield and accelerating anode on some cathode-ray tubes. The coating is on both the inside and outside of the tube. However, the coating on the outer wall is grounded, serving as a capacitor with the inside coating as the opposite plate. This capacitance will filter the high voltage applied to the inside coating.



Aquadag.

ARRESTER (LIGHTING)

A safety device intended to protect radio and television receivers as well as other electrical equipment from lightning or other forms of static electricity. (Certain atmospheric conditions can develop electrostatic charges on antenna elements.) A common lightning arrester has two electrodes within a gas-filled space. When the static charge exceeds a given value, as it would during a lightning strike, the gas is ionized to become a low resistance conductor. Thus the charge is bypassed to the ground away from the protected equipment. On tower antennas it is common to find two metal electrodes separated by an air gap that the electrostatic charges jump with a resulting ionization and bypass to ground.



Lightning arrester.

AUDIO-FREQUENCY FILTER

See Filter (Audio-Frequency)

AUDIO-FREQUENCY TRANSFORMER

See Transformer (Audio-Frequency)

AUTOTRANSFORMER

See Transformer (Autotransformer)

B

BALLAST RESISTOR

See Resistor (Ballast)

BANANA JACK

See Jack (Banana)

BANANA PLUG

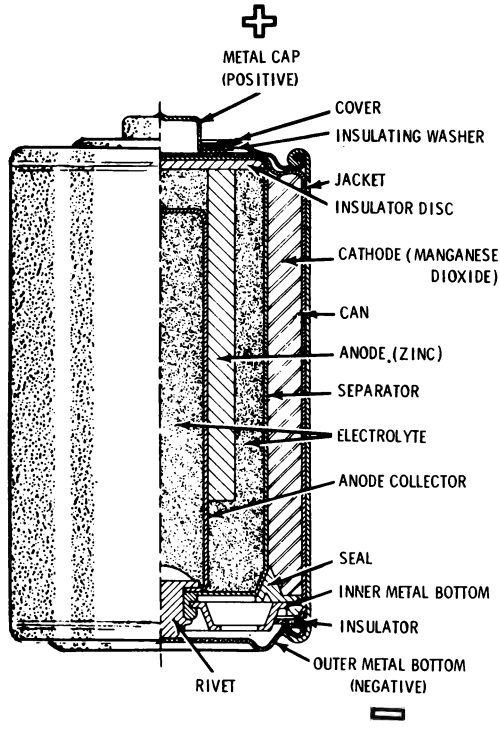
See Plug (Banana)

BATTERY

A cell or group of cells producing or storing electrical energy by chemical means.

BATTERY (ALKALINE)

A battery that produces electrical energy when an external circuit is present. The alkaline battery uses zinc as its negative electrode and



Alkaline battery.

manganese dioxide as its positive electrode. The manganese dioxide lines the outer metal container. A porous material separates it from the electroylte which is filling the center portion of the battery. A contact pin serves as a conductor from the internal zinc anode to the negative outer battery terminal. In operation the zinc anode takes electrons from the negative ions within the electroylte. The electrons travel through an external circuit (load) to the positive battery terminal and then to the manganese dioxide. Manganese dioxide is an alkaline material that initially loses some of its oxygen atoms to the electrolyte. But electrons coming from the external circuit will draw those positive oxygen atoms back to the manganese dioxide. Alkaline batteries have a voltage of 1.5 volts with a much longer life than the carbon-zinc cell.

BATTERY ELIMINATOR

An electronic device converting 115 volts ac to a low-voltage, high-current source that may be used instead of a battery. Such a battery eliminator serves as the battery of mobile and transistorized equipment during periods of testing and servicing. It is also often possible to use the battery eliminator to charge the lead-acid battery. Composed of a step-down variable transformer, full-wave rectifier, filter section, voltmeter, and an ammeter, the battery eliminator provides a variable source of dc power. A battery eliminator is also known as a power supply.

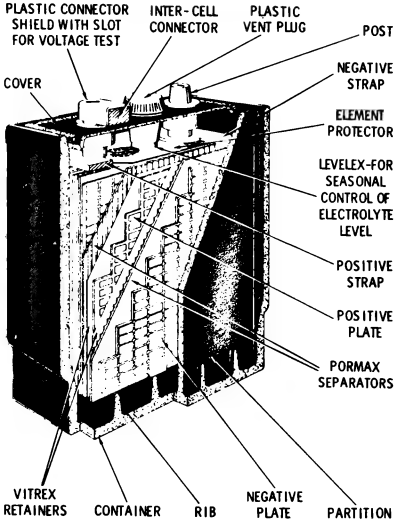
BATTERY (FUEL-CELL)

A battery producing electrical energy when an external circuit is present. The fuel cell replaces its electrical energy producing chemicals from external sources. In one type of fuel cell, the fuels used are oxygen and a hydrocarbon (diesel fuel). Entering the cell from opposite sides, the hydrocarbon breaks down into positive hydrogen ions and negative carbon ions while oxygen breaks down into positive ions. A porous catalytic anode produces a half-chemical reaction that removes the electrons from the fuels. Water is produced by another half-reaction occuring at the porous catalytic cathode. In our space explorations the fuel-cell battery has provided an adequate electrical supply, as well as water, without the necessity of having an additional fuel source.

BATTERY (LEAD-ACID)

The lead-acid battery is commonly referred to as the automobile battery. In contrast with other batteries, the lead-acid battery does not produce electrical energy. Instead, the lead-acid battery stores electrical energy in the form of

Battery eliminator.

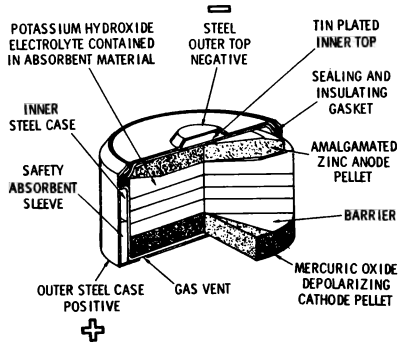


Lead-acid battery.

positive and negative ions within the sulphuric-acid electrolyte. The lead-acid cell consists of a number of positive plates containing lead peroxide and a number of negative (lead) plates. With separators between the plates, an electrolyte of sulphuric acid and water is used. During the discharge, negative ions within the electroylte move toward the negative plates to give off electrons and produce lead sulphate. Electrons entering the positive plate on discharge produce positive ions and water. As the result of lead sulphate and water being produced, the electrolyte becomes very diluted. However, when an electrical energy is supplied from an external source, the reverse chemical action occurs and the lead-acid battery is again charged. Fully charged, a lead-acid cell had a voltage of 2.2 volts and its electrolyte has a specific gravity of from 1.275 to 1.300. The capacity of a lead-acid battery is commonly rated in ampere-hours.

BATTERY (MERCURY)

A very small disk-shaped battery producing electrical energy by chemical reactions. The mercury battery derives its energy by mercury-oxide and zinc reacting with an electrolytic of potassium hydroxide.



Mercury battery.

Unlike other batteries, the mercury battery does not have a substantial decrease in voltage during use or before being placed into use. Due to this constant voltage the mercury battery may be used as a secondary voltage standard.

BATTERY (NICKEL-CADMIUM)

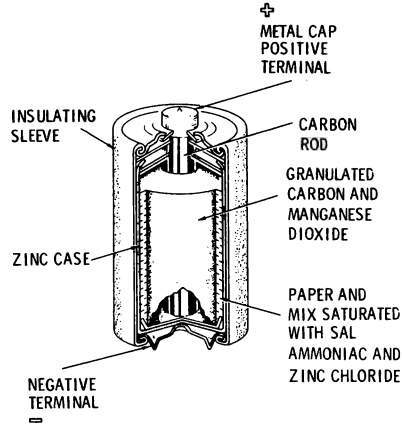
A rechargable battery using nickel and cadmium hydroxide electrodes in an electrolyte of potassium hydroxide. In its charged state, the nickel-cadmium cell has a positive terminal (cathode) of nickel hydroxide and a negative terminal (anode) of cadmium. During discharge the cadmium anode acquires oxygen and electrons from the electrolyte while the cathode loses oxygen and electrons into the electrolyte. Application of an external electrical source will recharge the nickel-cadmium cell. Such recharging can be repeated at least 100 times. Nickel-cadmium cells are available in button, rectangular, and cylindrical shapes. With a terminal voltage of 1.2 volts, the nickel-cadmium cells are often used in a series combination for higher voltages.

BATTERY (SOLAR)

See Photovoltaic Cell

BATTERY (ZINC-CARBON)

This is probably the most common type of battery due to its many different variations, as well as being inexpensive. The common flashlight battery is a single 1.5 volt zinc-carbon cell, while the 9-volt battery found in many transistor-



Zinc-carbon battery.

ized radios is a series-wired combination of six zinc-carbon cells. There are other zinc-carbon cell combinations available with voltages up to 510 volts. The zinc-carbon battery has a positive electrode of carbon and a negative electrode of zinc with an electrolyte of ammonium chloride, zinc chloride, and water.

BEAM-POWER VACUUM TUBE

See Electron Tube (Beam-Power)

BEARING (JEWEL)

See Jewel Bearing

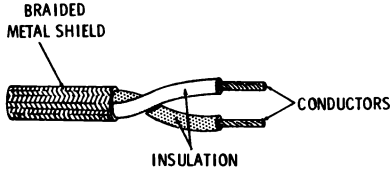
BREADBOARD (ELECTRONIC)

See Electronic Breadboard

C

CABLE (BROADCAST AUDIO)

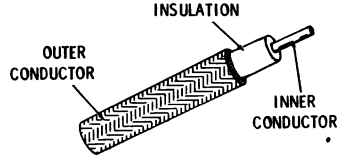
A cable of two insulated wires covered by a flexible, braided metal shield. The shield serves as a grounded outer conductor in balanced audio circuits and prevents undesirable radiations from entering or leaving the cable. In broadcast and recording studios, much of the audio equipment is interconnected with this type of cable.



Broadcast audio cable.

CABLE (COAXIAL)

A cable having one conductor centered within an outer tube-shaped conductor. For smaller amounts of rf power, the inner conductor may be stranded wire separated from the braided outer conductor by plastic with a vinyl jacket overall. A solid copper pipe outer conductor and a large solid copper conductor separated by perforated plastic wafers form the rigid type of coaxial cable used for the larger amounts of rf power. For example, the cable connecting a 10,000 watt fm transmitter to its antenna has an outer diameter of approximately four inches. To prevent the entry of moisture into that space between the inner and the outer conductors of rigid coaxial cables, compressed dry air or gas is used.



Coaxial cable.

CABLE (CATHODE-RAY TUBE)

A wire used to carry the high voltage (up to 50,000 volts) to the anode of a cathode-ray tube (crt), or television picture tube. It has a single conductor of stranded wire with a polyethylene insulation in a vinyl jacket.

CABLE (JUKE BOX)

A cable intended primarily for the hookup of coin-operated record players (juke boxes) and their speakers and selector systems. These cables are made with two conductors for single speaker connection, with three conductors for speaker plus record selecting, and with six conductors for stereo speakers and remote record selecting. All of these conductors are stranded, tinned, bare, or color coded for identification. Some of the conductors are also shielded.

CABLE (MICROPHONE)

One- or two-stranded conductors with braided or spiraled shields for use with microphones. With an overall diameter of less than 3/16 inch, the one conductor is very light and flexible; ideal for a lapel or lavalier microphone. For microphones having a low impedance, it is best to use the two-conductor type.

CABLE (MULTIPLE-CONDUCTOR)

A multipurpose cable used with intercommunication systems, telephone wiring, speakers, and control circuits. Some of these conductors are paired for use in telephone and other audio circuits while others are color coded for identification. Most of these conductors are stranded with plastic insulation in a vinyl jacket overall.

CABLE (POWER)

Cable used to conduct dc or ac power. Many cables can be used to conduct small amounts of power. However, with many types of electronic equipment (transmitters, hi-fi systems, etc.), it is necessary to go to a No. 18-gauge conductor with a current capacity of 5 amperes, or to No. 10-gauge conductor for 25 amperes.

CABLE (TWISTED-PAIR)

Two insulated conductors twisted together. Insulated by rubber or plastic, the two conductors commonly have an outer cover of glazed cotton braid. Another form of twisted-pair cable has a copper-braid jacket that serves as a shield. Both the shielded and the unshielded types of the twisted-pair cable are used for audio equipment, but the

unshielded type is limited primarily to telephone and intercom service.

CAPACITANCE DECADE BOX

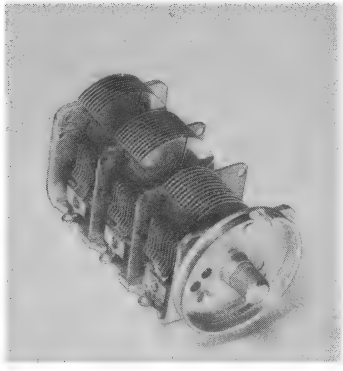
See Decade Capacitance Box

CAPACITOR

Two conducting elements, or plates, separated by an insulating material referred to as the dielectric. The primary purpose of a capacitor is to acquire an electrical charge. In acquiring or losing that charge the capacitor blocks the flow of dc, presents a reactance to varying ac, and forms a resonant circuit with the inductance.

CAPACITOR (AIR-VARIABLE)

Known also as a tuning capacitor, the air-variable capacitor has a number of movable plates (rotor) meshing into a number of stationary plates (stator). Mounted on a shaft, the rotor can be turned to put different amounts of area parallel with the stator to vary the capacitance. Normally two or three air-variable capacitors are ganged on a single shaft. Air-variable capacitors normally have capacitances ranging from 15 to 450 pF.



Air-variable capacitor.

Another type of air-variable capacitor is the neutralizing capacitor. With two metal discs (about 2 inches in diameter) arranged with a screw adjustment, the capacitance ranges from 2.3 to 10 pF with a voltage rating of more than 3000 volts.

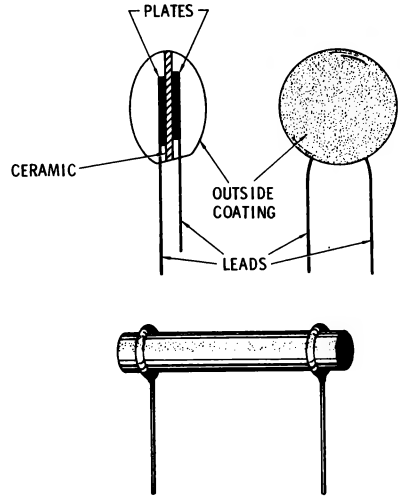
CAPACITOR (CERAMIC)

A capacitor using a ceramic material as a dielectric between silver-plated elements. One variety of ceramic capacitor uses a tube made of ceramic with its elements silver-plated on the inside and outside surfaces. These tubular-ceramic capacitors have capacitances ranging from 3.0 to 10,000 pF and voltages up to 500 volts.

Disc-ceramic capacitors consist of deposited silver plates on a thin disc of ceramic material. With tinned-wire leads, the disc-ceramic capacitor is coated in plastic and marked with its capacitance. Working voltages from 3 volts to 6000 volts and capacitances of 3.0 pF to 2.5 μF make the disc-ceramic capacitor very versatile. Their dimen-

sions are typically 1/4 to 3/4-inch diameters and 5/32-inch thickness. The disc-ceramic capacitor is less likely to break and has a better size-to-capacitance ratio.

Ceramic material has several different formulas with each formula producing a material of different characteristics. One type of ceramic for example, has a characteristic of expansion and contraction with changes in temperature. Use of this type of ceramic gives a temperature-compensating capacitor. In parallel with a resonant circuit the temperature-compensating, ceramic capacitor corrects any frequency shift caused by temperature changes.



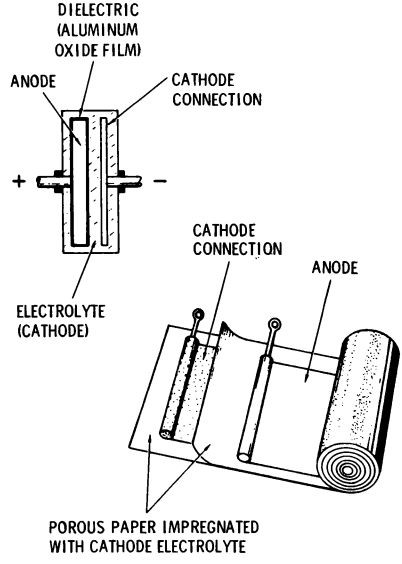
Tubular and disc-ceramic capacitor.

CAPACITOR (DOORKNOB)

With the physical shape of a doorknob, the doorknob capacitor is intended for use in the high-voltage (10, 20, and 30 kilovolts) sections of television receivers. A typical capacitance value for a doorknob capacitor is 500 pF. The molded plastic outer shell has dimensions up to 1-5/16 diameter by 1-1/4 inches in length with a variety of screw-in terminals.

CAPACITOR (ELECTROLYTIC)

A capacitor using an aluminum foil as one plate while a current-carrying fluid, known as the electrolyte serves as its second plate. A coating of aluminum-oxide forms the dielectric. Another aluminum foil is used to form an electrical



Electrolytic capacitor.

contact with the electrolyte. To prevent spilling or leaking, the electrolyte is contained in a porous paper and wound between layers of foil. By using two, three, or four sheets of foil as a common contact, as many as four capacitors can be built into one unit.

The aluminum-oxide and the aluminum foil form a semiconductor, passing current through the oxide film toward its foil. Thus the combination is a conductor in one direction and a capacitor in the opposite direction. In other words the electrolytic capacitor is polarized and must be installed so that its applied voltage encounters the high resistance direction. The common electrolytic capacitor cannot be used with ac; a special form of electrolytic capacitor must be used. It has aluminum-oxide film on both aluminum foils and an electrolytic fluid establishing a floating negative plate.

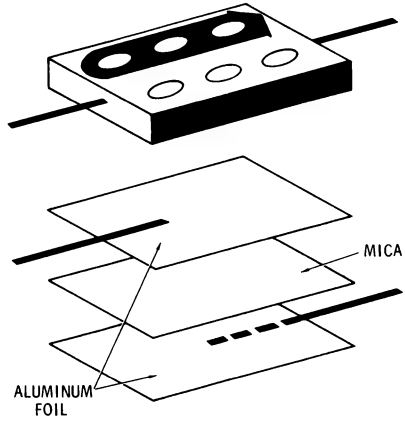
Ratings for electrolytic capacitors range from 1 μF to 300 μF at a working voltage of 1 to 500 volts. Electrolytic capacitors are used in power-supply filtering, transistor circuit coupling, and as audio-frequency, bypass capacitors.

CAPACITOR (FEEDTHROUGH)

A form of ceramic capacitor designed for a single hold mounting, where it is necessary to bypass rf current to ground. With a 1/4 inch diameter, these feedthrough capacitors have mounting nuts or flanges that solder to the chassis. Their capacitance ranges from 50 to 2300 pF.

CAPACITOR (MICA)

A capacitor having mica as its dielectric and aluminum foil or deposited silver as plates. With molded bakelite or dipped plastic encasements, mica capacitors have capacitances from 5 to 10,000 pF and up to 500 volts working voltage. The doorknob capacitor is a type of mica capacitor.



Mica capacitor.

CAPACITOR (PAPER)

Constructed from paper which is impregnated with oil, wax, or some synthetic material and rolled between two metal foils which become the anode and cathode. Rolled

in this manner, large plate areas can be concentrated within a small volume. Paper capacitors have capacitances from 0.0001 to 1.0 μF, at 200 to 5000 volts. A paper capacitor can be used in almost any application. However, in larger capacitance, it is often bulky.

CAPACITOR (PLASTIC-FILM)

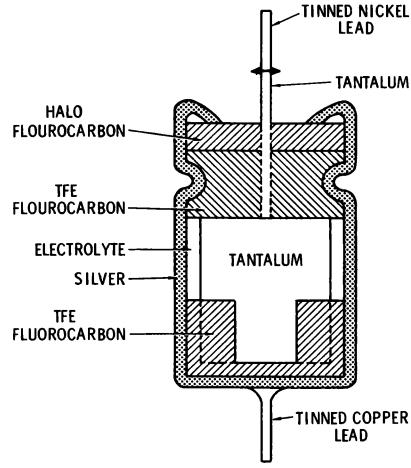
See Capacitor (Synthetic-Film)

CAPACITOR (SYNTHETIC-FILM)

A capacitor closely related to the paper capacitor in construction but uses plastic film and paper as the dielectric. Films of polystyrene or *Mylar* polyester are used. Since plastic film is much denser, has a higher dielectric constant, and is more free of impurities, the plastic- or synthetic-film capacitor has a greater capacitance-to-volume ratio than the paper capacitor. Synthetic-film capacitors are more stable and are affected little by temperature changes. Most *Mylar*-film capacitors are rated at 100 to 600 volts with capacitances of 0.001 to 2.0 μF.

CAPACITOR (TANTALUM)

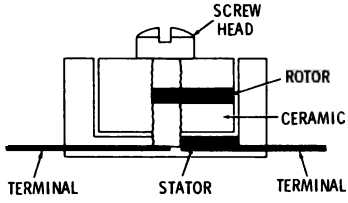
A capacitor normally confined to military equipment and high quality devices. However, their growth in smaller items such as transistor radios are becoming more popular. Tantalums normally have a higher cost but they provide more capacitance for their size. They range in value from .25 to 2200 μF, have excellent stability, and can be stored almost indefinitely. Tantalums are available in a polarized and nonpolarized foil form as well as a sintered anode form.



Tantalum capacitor.

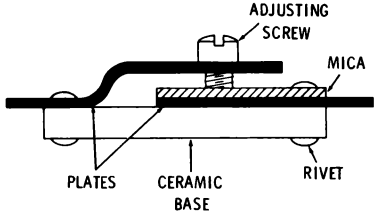
CAPACITOR (TRIMMER)

Trimmer or padder capacitors are variable capacitors used where the variation is not frequent or where fine adjustment of a tuned circuit is desirable. Ceramic trimmers are disc shaped with a semicircular stator plate mounted within the base. Set into a cavity of the base is a disc of ceramic material with the rotor plate em-



Ceramic trimmer capacitor.

bedded. With a screwdriver slot in the rotor disc, more or less of the rotor plate may be exposed to the stator plate so that the capacitance is varied. Ceramic trimmers ordinarily have maximum capacitances of less than 100 pF at 500 volts.



Mica trimmer capacitor.

A mica trimmer capacitor has a layer of mica between two metal plates riveted to opposite ends of a ceramic or bakelite block. An adjustment screw at the center varies the spacing and therefore the capacitance.

The tubular-ceramic trimmer capacitor has a silver coating on the inside of each of its two ceramic tubes. One tube fits into the other and can be moved by means of a screw arrangement. Thus, the walls of the inner tube become the dielectric. Tubular-ceramic trimmers have small capacitances but provide precise adjustment. Another form of tubular trimmer uses a glass tube, rather than ceramic, for the dielectric.

CARBON-COMPOSITION RESISTOR

See Resistor (Carbon-Composition)

CARBON MICROPHONE

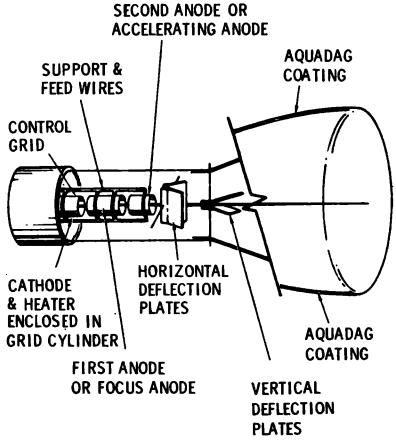
See Microphone (Carbon)

CATHODE-RAY TUBE

An electron tube capable of forming an electron beam and thereby a visible image. As electrons emit from the cathode and are attracted toward the anode at the large end of the tube, a control grid, a focusing anode, and an accelerating anode form the electrons into a sharp, well-defined, beam.

The face of the tube has a coating of phosphor on the inside of the glass. Wherever the electron beam strikes the phosphor, a spot of light is produced. As the beam is moved vertically or horizontally, the phosphor continues to glow and various forms or pictures appear on the face of the tube. Movement of the beam is accomplished by electrostatic or magnetic de-

flection. Electrostatic deflection is accomplished by the vertical- and horizontal-deflection plates within the tube. For the magnetic deflection cathode-ray tube, a horizontal and vertical coil combination, referred to as a deflection yoke, is mounted around the outside of the neck of the tube. The magnetic-deflection cathode-ray tube is the type used primarily in television receivers, while the oscilloscope (used to display the waveforms of varying voltages or currents) commonly uses the electrostatic deflection cathode-ray tube. Cathode-ray tubes are usually rated by their screen diameter, or by the diagonal measurement of the rectangular screen. Phosphors for the cathode-ray tube may be red, green, blue, white, or other colors. Cathode-ray tubes used for black and white television have white phosphors, while color receivers use a three gun (three electron beams) cathode-ray tube with a combination of red, green, and blue phosphors.



Cathode-ray tube.

CAVITY (RESONATING)

An inclosed space within which an electromagnetic wave of extremely short wavelength becomes resonant. That is as the wave strikes the sides of the resonating cavity, the resulting reactions encourage the wave to continue its variations. The resonant cavity is the same as a parallel LC resonant circuit at the lower radio frequencies. As the dimensions of the resonating cavity become smaller, its resonant frequency increases.

CERAMIC CAPACITOR

See **Capacitor (Ceramic)**

CERAMIC MICROPHONE

See **Microphone (Ceramic)**

CERAMIC PHONO CARTRIDGE

See **Phono Cartridge (Ceramic)**

CHASSIS

A metal base used for the mounting of electronic components. In

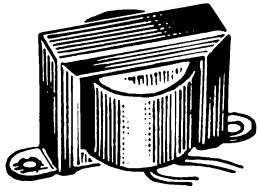
most situations the chassis also serves as a common ground and carries current. Therefore, the chassis should be of low resistance and no larger than necessary.

CHASSIS CONNECTOR

See Connector (Chassis)

CHOKE (POWER-SUPPLY FILTER)

A large iron-core inductor used to reduce current variations in power supplies. The result of rectifying alternating current is a current that pulsates. The power-supply filter choke tends to hold the current at a constant level.

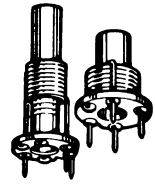


Filter choke.

With filter capacitors also tending to hold the rectified current to a constant level, the output current becomes nearly pure dc. Power-supply filter chokes have a great many turns about the center tongue of an iron-core. The iron-core is built up of many E and I shaped laminations. Such power-supply filter chokes have ratings of 5 to 50 henrys at up to 0.3 ampere.

CHOKE (RADIO-FREQUENCY)

A choke whose inductance is used to block the passage of radio-frequency (rf) current. In many rf voltage or power amplifiers it is desirable to keep the rf current out of the dc power supply, as well as to force all of the rf current into the LC resonant circuit and its load. Most radio-frequency chokes have an air core, but with lower radio frequencies the inductance must be larger and it may be best to use a ferrite (powdered-iron) core.

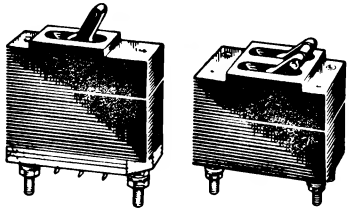


Rf choke.

CIRCUIT-BREAKER (MAGNETIC)

A safety device preventing current from exceeding a given value. The magnetic circuit-breaker is basically a switch having a spring-loaded plunger. Normally this plunger presses against and closes the switch contacts. But an electromagnet (or solenoid) surrounds the plunger and carries the line current. When the line current exceeds a given value, the magnetic

force of the solenoid overcomes that of the spring and pulls the plunger away from the switch contacts. Thus, current exceeding a given value causes the circuit to be broken. The value of current that will break the circuit is referred to as the *trip point* and is adjusted by increasing or decreasing the spring tension. Magnetic circuit breakers used in electronic equipment have current ratings from 1 to 20 amperes.



Magnetic circuit breaker.

CIRCUIT-BREAKER (THERMAL)

A circuit breaker using a bimetallic switch contact. Excessive current develops heat within the bimetallic contact and causes it to bend (or curl) away from the fixed contact. Thus, the circuit is broken when the current reaches the *trip point* value and heats the bimetallic contact to a bent condition. A set screw applying pressure against the bimetallic contact can vary the trip point over a small range of current values. The range of current covered by thermal circuit breakers is from 0.5 to 15 amperes.

COAXIAL CABLE

See Cable (Coaxial)

COAXIAL CONNECTOR

See Connector (Coaxial)

COAXIAL SPEAKER

See Speaker (Coaxial)

COIL (DEGAUSSING)

See Degaussing Coil

COIL (INDUCTOR)

See Inductor Coil

COIL (SLUG-TUNED)

See Inductor (Slug-tuned)

COLOR BAR-DOT GENERATOR

A test instrument used in the alignment of color television receivers. The color bar-dot generator develops a series of modulated signals giving various test patterns on the screen of the television receiver. The color bar-dot generator also provides red, green, and blue signals for the checking of purity. Such an instrument makes it possible to adjust the

color receiver for the best possible reception.

COMPACTRON

A type of vacuum tube construction with a number of electron-tube assemblies in a single glass envelope. *Compactron* is the registered trade mark of General Electric.

CONDENSER MICROPHONE

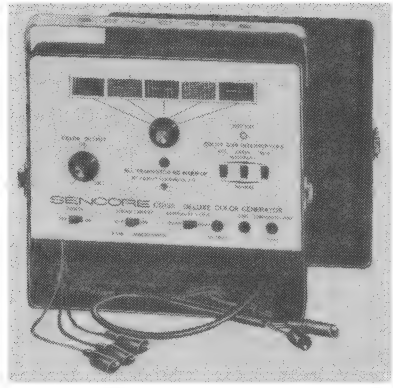
See Microphone (Condenser)

CONE (INSULATOR)

See Insulator (Cone)

CONNECTOR (CABLE)

A component used to make temporary connections between two lengths of cable or between a length of cable and some piece of electronic apparatus. For example, a microphone is connected to an amplifier by means of a cable connector. If it is desirable to use additional lengths of microphone cable, other cable connectors will be used. There are also connectors for special cables such as power cables and speaker cables. Cable connectors come in a variety of types. For example, single or multiple contacts, shielded or unshielded, and locking or nonlocking.



Color bar-dot generator.

CONNECTOR (CHASSIS)

A component used to make temporary connections between a chassis and a cable or between two chassis sections. For example, a chassis connector is mounted on the chassis of an amplifier to receive the contacts of the microphone cable connector. Chassis connectors come in a variety of forms. For example, single or multiple contacts, shielded or unshielded, polarized or nonpolarized, and locking or nonlocking.

CONNECTOR (COAXIAL)

A connector used with flexible coaxial cable. The outer shell is connected to the outer conductor.

Also, coaxial cable connectors have single or double inner contacts and are available as cable end connectors, cable-to-chassis connectors, and cable-splicing connectors.

CONSTANT-VOLTAGE TRANSFORMER

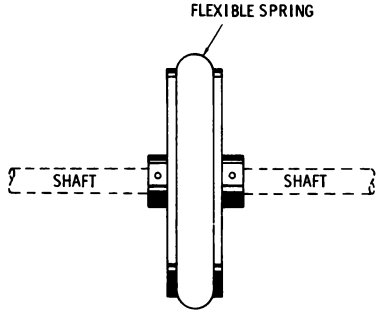
See Transformer (Constant-Voltage)

COPPER-OXIDE DIODE

See Diode (Copper-Oxide)

COUPLING (FLEXIBLE)

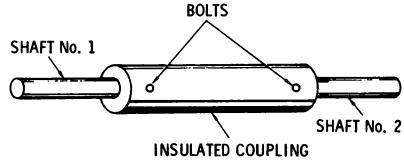
A flexible material used to couple two shafts. When two shafts, such as those on a motor and a generator, are to be connected it is not always possible to have them in true alignment. The flexible coupling consisting of two pieces of leather, a length of rubber hose, or a flexible spring takes up the added twist produced by that misalignment.



Flexible coupling.

COUPLING (INSULATED)

An insulating material used as a coupling between two shafts. There are situations in electronic equipment where it is convenient to mechanically couple shafts of variable capacitors or variable resistors. But at times the one shaft may be at ground potential while the second shaft has a different potential. Naturally, if we use a conducting material to couple these two shafts, the circuit will be shorted and excessive current may result.



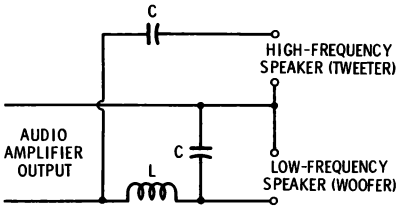
Insulated coupling.

CRIMP-ON TERMINAL

See Terminal (Crimp-On)

CROSSOVER NETWORK

A filter circuit used between the audio amplifier and its speakers for the purpose of dividing the low and high frequencies. Since some speakers reproduce low frequencies better than high frequencies, it is

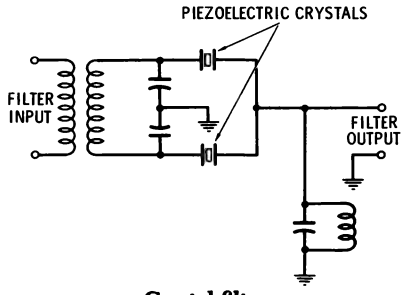


Crossover network.

more efficient to feed only low-frequency power into those speakers. Inversely, it is more efficient to feed only high-frequency power into those speakers that reproduce high frequencies best. The crossover network consists of a low-pass filter and high-pass filter in parallel with the amplifier output.

CRYSTAL FILTER

A type of rf bandpass filter using quartz crystals as frequency-determining elements. The quartz crystals act as very high-Q series resonant circuits to make the crystal filter very selective. Therefore, the crystal filter will pass a very narrow band of frequencies and is much more selective than a filter using only inductance and capacitance circuit elements.



Crystal filter.

CRYSTAL MICROPHONE

See Microphone (Crystal)

CRYSTAL PHONO CARTRIDGE

See Phono Cartridge (Crystal)

CRYSTAL SOCKET

See Socket (Crystal)

D

D'ARSONVAL METER

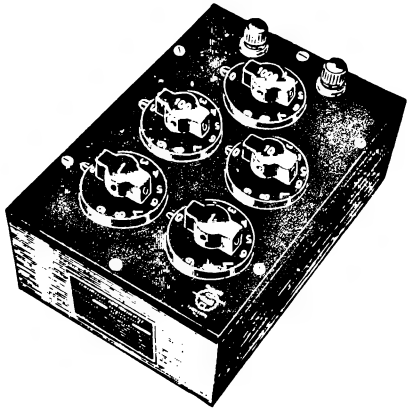
See Meter (D'Arsonval)

DECADE CAPACITANCE BOX

A series of precision capacitors with a switch or terminal arrangement to provide from 100 pF to 0.111 μF in 100 pF steps. This gives considerable flexibility for laboratory and circuit development as well as circuit substitutions.

DECADE RESISTANCE BOX

A series of precision resistors with a switch arrangement to provide from 1.0 ohm and up in 1.0



Decade resistance box.

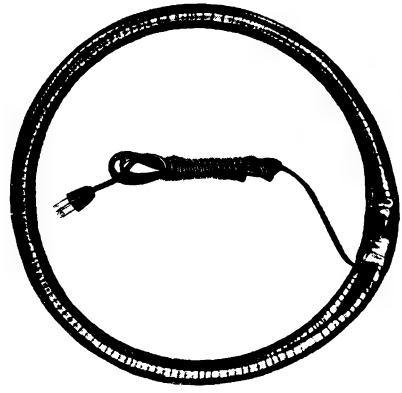
ohm steps. This gives considerable flexibility for laboratory and circuit development work as well as circuit substitutions.

DEFLECTION YOKE

A system of electromagnetic coils used to deflect the electron beam within a cathode-ray tube. As used in the usual television receiver, the deflection yoke consists of two vertical deflection coils and two horizontal deflection coils. All four coils are built within a framework and positioned about the neck of the picture tube. The cathode-ray tube used in radar and sonar systems also use deflection yokes.

DEGAUSSING COIL

An electromagnetic coil used to demagnetize a color television picture tube. Picture tubes for color television receivers are extremely sensitive to changes in magnetic fields. Even the difference in the earth's magnetic field at different locations can magnetize portions of the picture tube and cause distortion. The degaussing coil consists of several turns of wire forming a hoop about 9 to 12 inches in diameter and a cord-plug combination for connection with the 115-volt ac. Moving this degaussing coil in front of the face of the picture tube demagnetizes those portions causing the distortion. Built-in degaussing coils are found in most of the newer color television receivers.



Degaussing coil.

DIAC

A solid-state device having negative resistance characteristics. The diac is constructed of three layers of doped crystalline material in

either a pnp or npn configuration. The diac will pass only a small leakage current until a breakover voltage is reached. Beyond this point, the current increases as the applied voltage decreases (negative resistance). Because the diac acts in the same manner regardless of the polarity of the applied voltage, it is a bilateral device. Diacs are often used in conjunction with a triac (another bilateral silicon controlled rectifier) phase control circuit.

DIODE (COPPER-OXIDE)

A form of semiconductor used as a rectifier in ac meters. The copper-oxide diode consists of a number of copper plates separated by copper-oxide. Copper-oxide is a semiconductor freely passing current in one direction while presenting high resistance to current attempting to flow in the opposite direction. The capacitance existing between the plates of a copper-oxide diode makes it very inefficient at high frequencies.

DIODE (ELECTRON TUBE)

See Electron Tube (Diode)

DIODE (GERMANIUM)

A variety of solid-state semiconductors using germanium crystal-

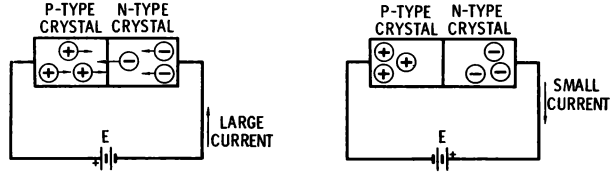
Germanium diode.

line material. One type of germanium diode has point-contact construction while others have a pn junction.

Explanation of solid-state semiconductor operation can be found under *Diode (Junction)* and *Diode (Point-Contact)*.

DIODE (JUNCTION)

A semiconductor having a section of p-type material and a section of n-type material. The p-type section is doped to have an abundance of positive charge carriers, referred to as holes. An abundance of electrons (negative charge carriers) characterizes the n-type section. At the junction of the two sections, a charge barrier or depletion area is formed that opposes carrier movement. When the p-type section is connected to an external positive voltage, holes move toward the junction to overcome the charge barrier and on toward the n-type section terminal. At the n-type section terminal, the holes are filled by electrons coming from an external voltage source. In turn, electrons move from the n-type section to the positive voltage source. The overall effect is that current flows in the external circuit. By readily per-



Pn junction.

mitting current flow, the positive voltage connection to the p-type section is referred to as the forward-bias condition. The reverse-bias condition (negative voltage connected to p-type section) intensifies the charge barrier and opposes current flow. So the pn junction, or junction diode, is a semiconductor readily passing current in one direction and opposing current flow in the other direction. Junction diodes made of silicon are used for power rectification while germanium junction diodes are used for rf detection.

DIODE (LIGHT-EMITTING)

A semiconductor capable of emitting light. The light-emitting diode consists of a pn junction diode having crystalline materials added at its junction. With a forward voltage, the various current carriers combine at the junction and give off a radiation. The various crystalline materials make these radiations detectable either as visible light or as invisible infrared and ultraviolet light. Some crystalline materials also produce light having laser action. A primary use of light-emitting diodes producing visible light is the luminescent display of letters and numerals. Being very small, it is possible to fit 88 light-emitting diodes into a wrist-watch to display the time in direct-reading numerals.

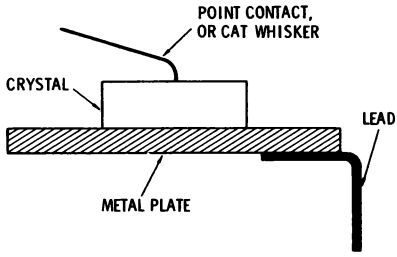
DIODE (MERCURY-VAPOR)

See Electron Tube (Mercury-Vapor Diode)

DIODE (POINT-CONTACT)

A solid-state component having a block of p-type or n-type crystal mounted on a metal plate and a small point contact on the opposite side. When an external voltage is applied with the positive to the point contact on an n-type block, the electrons are readily drawn to that point. The larger area of the plate (negatively charged) can readily attract an equal number of positive holes. Therefore, a point-contact diode having an n-type block is forward-biased when its

point contact is positive. Inversely, the reverse-biased condition for a point-contact diode having an n-type block has a negative point contact. In such a reverse-biased condition the positive plate attracts a great many more electrons



Point-contact diode.

than the point-contact can attract holes. There is also a theory that the initial voltage applied to the point-contact diode develops an area of p-type material immediately below the point contact, which is then the equivalent of a pn junction diode. Regardless of theory, the point-contact diode is a semiconductor using germanium or silicon crystal blocks. Unable to handle much power, point-contact diodes are used for rf detection.

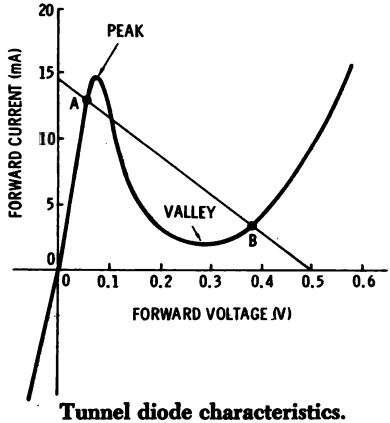
DIODE (SILICON)

A variety of solid-state semiconductors using silicon crystal material. One type of silicon diode has a point-contact construction while others have a pn junction.

Explanation of solid-state semiconductor operation can be found under *Diode (Junction)* and *Diode (Point-Contact)*.

DIODE (TUNNEL)

A solid-state, two-element device having a negative-resistance characteristic. The p- and n-type sections are heavily doped with impurities. With this high impurity density, the charge barrier (depletion area) is very narrow.



Tunnel diode characteristics.

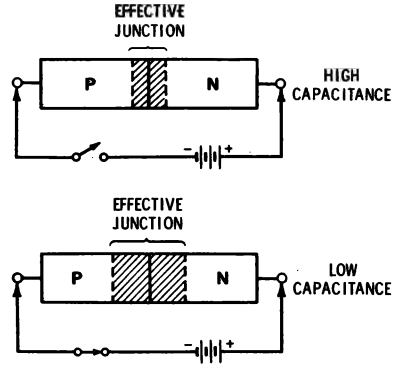
As a result, electrical charges seem to tunnel under or through the charge barrier. This tunneling gives a negative-resistance for a portion of its operating range. That is, its current decreases as the voltage increases, and this makes it possible for the tunnel diode to achieve amplification, pulse generation, and rf voltage generation.

DIODE VACUUM TUBE

See Electron Tube (Diode)

DIODE (VOLTAGE-VARIABLE CAPACITOR)

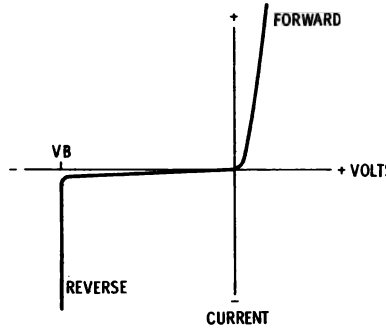
A variety of solid-state semiconductors serving as a variable capacitor controlled by the applied voltage. In parallel with a resonant circuit, the voltage-variable capacitor becomes a variable reactor (reactance) and is often referred to as a *varactor*. As the reverse-bias voltage across the device increases, its capacitance decreases and the resonant frequency increases. This makes the voltage-variable capacitor diode useful in frequency control, amplifying, frequency multiplying, and phase-modulating systems.



Voltage-variable capacitor diode.

DIODE (ZENER)

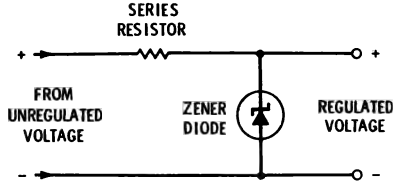
A solid-state semiconductor functioning as a voltage regulator. Operated with a reverse-biased condition, the zener diode passes little or no current until the breakdown or avalanche point is reached. At this avalanche point the current increases to a high level unless limited by a series resistor. Being in parallel with the load, any change in the voltage across that load will cause a change in the zener diode current, but the voltage across that diode remains at its avalanche point. Thus, any change in voltage will quickly be developed by the series resistor.



Zener diode characteristic.

DOORKNOB CAPACITOR

See Capacitor (Doorknob)



Zener diode.

DYNAMIC MICROPHONE

See Microphone (Dynamic)

DYNAMIC SPEAKER

See Speaker (Dynamic)

DYNAMOMETER (METER)

See Meter (Dynamometer)

DYNAMOTOR

A motor-generator combination used to convert a low-voltage dc to a high-voltage dc. Assembled in one unit and using the same shaft, the dynamotor consists of a motor that operates on low dc voltages and a generator that develops high dc voltages. An input voltage from 6 to 28 volts is typical of dynamotors, while their outputs range from 250 to several thousand volts.

E

ELECTROLUMINESCENT PANEL

A light source using phosphor material between thin sheets of plastic. When connected to 120 volts ac, these electroluminescent panels give off low-intensity light of green, blue, yellow, or white color. With a thickness of less than 1/32 of an inch, the electroluminescent panel is very flexible and draws negligible current.

ELECTROLYTIC CAPACITOR

See Capacitor (Electrolytic)

ELECTROMAGNETIC DEFLECTION COIL

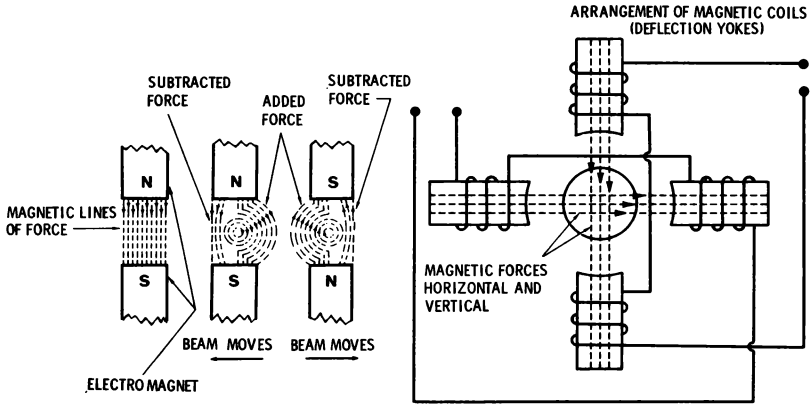
A coil located around the neck of a cathode-ray tube, for the purpose of deflecting the electron beam within the tube.

ELECTRONIC BREADBOARD

Any type of board with perforations, clips, sockets, and other temporary connecting devices. Such a device is often used in experiments and circuit development.

ELECTRON TUBE (ACORN)

A tube designed for use with uhf frequencies. The tube has no base, and the leads come straight out to the sides of the tube. Therefore, a special socket must be employed to connect the tube into a circuit. The element area in the tube is kept small to reduce interelectrode capacity. The short, direct leads reduce load inductance.

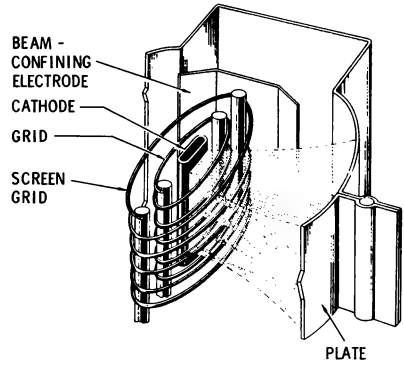


Electromagnetic deflection coil.

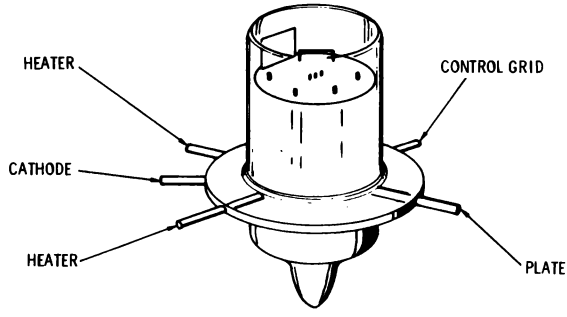
Developed during the second world war, the acorn tube is still used to some extent.

ELECTRON TUBE (BEAM-POWER)

An electron tube having a pair of metal vanes, referred to as beam-forming plates, located between the screen grid and the anode. These plates reduce the secondary emission and form the electrons go-



Beam power tube.



Acorn tube.

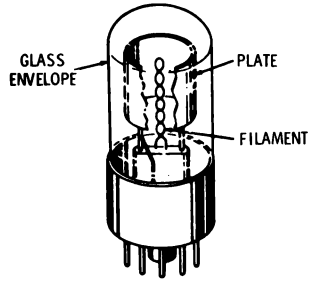
ing toward the anode into a beam. The beam-power tube is capable of delivering high power at low anode voltages. The beam-power tube is used in both radio- and audio-frequency power amplifiers.

ELECTRON TUBE (DIODE)

An electron tube having two electrodes, a cathode and an anode, within a glass enclosed vacuum. The heated cathode emits electrons that are attracted by a positively charged anode (plate). Since the anode will not attract electrons when negatively charged, the diode will only conduct in one direction. That is, it readily passes current in one direction while opposing current in the opposite direction. In this manner, the diode acts as a rectifier by passing current only during the half of a cycle when the anode is positive. This makes it useful as a detector of rf signals and converting of ac to dc.

ELECTRON TUBE (FIELD-EFFECT)

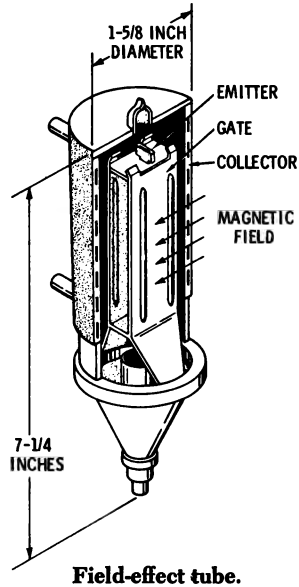
A triode with a nonintercepting control gate instead of an ordinary grid. When a high positive voltage is applied to the gate, current will start to flow creating a strong electric field between the cathode and gate. This causes the electron beam to pass through the gates to the anode.



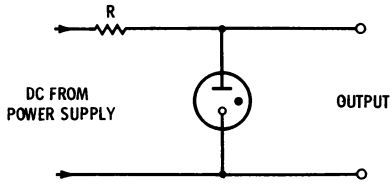
Diode tube.

ELECTRON TUBE (GASEOUS VOLTAGE-REGULATOR)

A cold-cathode or glow discharge tube designed to provide a regulated direct-voltage output. The gaseous voltage-regulator has an avalanche point at which the current conduction increases very rapidly. In series with a current-



Field-effect tube.



Voltage-regulator tube.

limiting resistor, the voltage regulator drops a constant voltage at the avalanche point. The load in parallel with the voltage regulator will therefore be held constant.

ELECTRON TUBE (IMAGE ORTHICON)

An electron tube serving as the eye of the television camera. The image orthicon consists of a photosensitive face or target, an electron gun, and deflection plates or

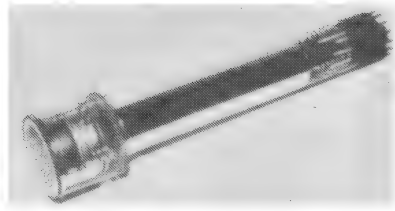
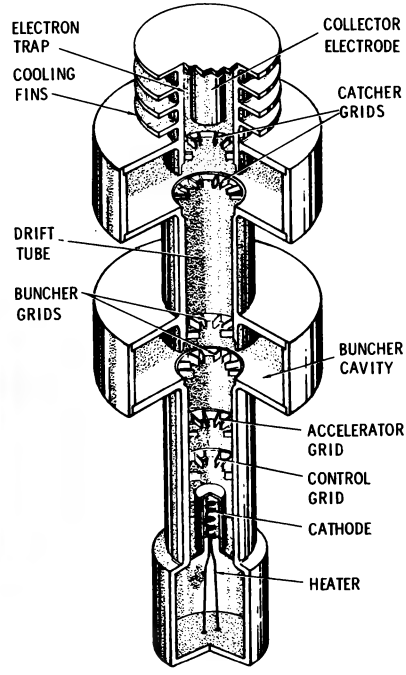


Image orthicon.

coils. When an image is focused upon the target of the tube, those areas exposed to bright light will release a great number of electrons. Therefore areas exposed to less light will release fewer electrons. Then, as the electron beam sweeps horizontally and vertically over the target, a voltage is produced with variations equivalent to the image. Upon amplification, this video voltage can modulate a radio-frequency wave to become a television broadcast.

ELECTRON TUBE (KLYSTRON)

An electron tube utilizing resonant cavities for the production



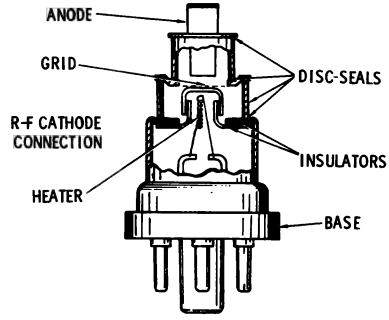
Klystron.

and amplification of uhf and microwave frequencies. By using these resonant cavities, it becomes possible to operate at frequencies

much higher than those found with conventional tubes. Electrons emitted from the cathode are accelerated by a grid into a resonant cavity. In the resonant cavity, the electrons create a high-frequency electrostatic field. This high-frequency field accelerates some of the electrons while retarding other electrons to produce a velocity-modulated electron stream. A second resonant cavity, known as the catcher, further acts upon the electron stream to determine its frequency. To develop oscillations, a portion of the signal developed within the catcher cavity is returned to the first or buncher cavity. This is similar to the familiar tuned-plate, tuned-grid oscillator with the LC tuned circuits replaced by the resonant cavities within the klystron. When used as an amplifier, the feedback loop is not used and a high-frequency signal is injected into the buncher cavity.

ELECTRON TUBE (LIGHTHOUSE)

A tube designed for use with microwave frequencies. However, the lighthouse tube can handle more power than the acorn tube due to its larger element area. Inductance is kept low since the tube has no leads. The pins at the base are for support and only the heater is connected to them. Used as a cavity resonator, connections to the

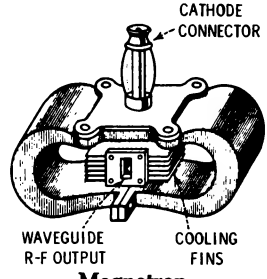


Lighthouse tube.

various tube elements are made through "fingers" inside the cavity.

ELECTRON TUBE (MAGNETRON)

An electron tube using resonant cavities for the development of microwave frequency energy.



Magnetron.

The magnetron has a heated cathode and a large copper anode mounted within an electromagnetic winding. Within the anode ring are a number of holes and slots forming resonant cavities. The positively charged anode attracts electrons away from the cathode, while

the magnetic field turns those electrons from that direct path toward the anode. As a result, the electrons do not reach the anode but form a rotating cloud of electrons. In passing an anode slot, that slot and associated cavity acquire energy; alternate slots absorb energy from and give energy to the rotating electron cloud. Thus, the speed of the rotating electron is controlled by the dimensions of the resonant cavities. A probe, or small antenna inserted into one of the resonant cavities couples the microwave energy to other electronic equipment. Since only one of the resonant cavities absorbs any of the microwave energy and few electrons return to the cathode, the efficiency for the magnetron is high.

ELECTRON TUBE (MERCURY-VAPOR DIODE)

An electron tube having two electrodes, a cathode and anode, within a glass enclosure containing mercury vapor. The mercury vapor becomes ionized when heated to give a constant potential of 15 volts between the cathode and the anode. In other respects the mercury vapor diode tube acts much like the diode electron tube and is also a semiconductor. Used primarily in power rectifiers, the mercury vapor diode tube can carry 250 mA at potentials as high as 10,000 volts.

ELECTRON TUBE (MULTISECTION)

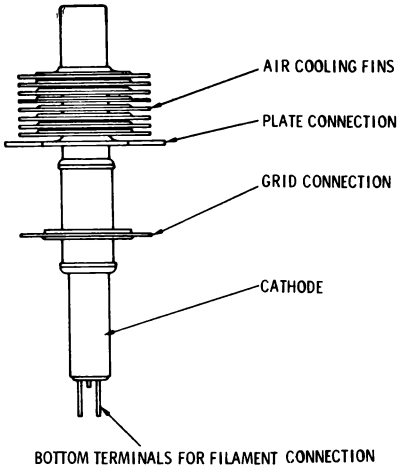
A glass or metal enclosure containing two or more tube structures. The medium within the enclosure is usually a vacuum. Each tube structure functions independently. A multisection electron tube containing two diodes is referred to as a duodiode, while one containing two triodes is a duotriode. Other multisection electron tubes are triode-pentodes and pentode-pentodes. Popularity for multisection electron tubes has come from their savings in space and cost.

ELECTRON TUBE (NUVISTOR)

An electron tube having a miniature ceramic-metal construction. Electrodes within the *Nuvistor* are supported by a cantilever mechanism to provide greater ruggedness. *Nuvistor* is a registered trademark term owned by RCA and its small physical dimensions are ideal for use in very-high-frequency circuits like television tuners.

ELECTRON TUBE (PENCIL)

Like the lighthouse tube, the pencil tube has only the filaments connected to the base terminals and has the same type of element connections. The pencil tube is used for uhf low-power transmitters and

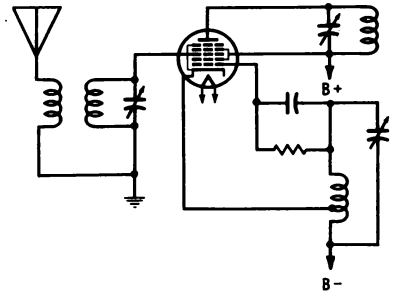


Pencil tube.

has air cooling fins to help dissipate the heat.

ELECTRON TUBE (PENTAGRID-CONVERTER)

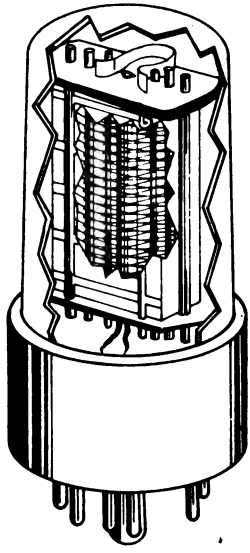
An electron tube having seven electrodes (a cathode, five grids, and an anode) within a glass, or metal-enclosed vacuum. The pentagrid converter serves the purpose of the local oscillator, the frequency mixer and first detector of a superhetrodyne radio receiver. A frequency equaling that of the received rf signal plus the i-f frequency of the receiver is developed by an oscillator circuit using the cathode and the first two grids as a triode. Thus, the electron movement toward the anode is varied at the frequency of this oscillator. Acting upon the third grid, the received rf signal adds its varitions to the electron movement. The resulting movements of electrons arriving at the anode contain the frequencies of the received signal the oscillator, and the i-f frequency (the received signal minus the oscillator frequency). From this complex wave, the i-f amplifiers select and amplify the desired frequency.



Pentagrid-converter circuit.

ELECTRON TUBE (PENTODE)

An electron tube having five electrodes (cathode, three grids, and anode) within a glass- or metal-enclosed vacuum. The cathode, at the center of the tube, emits electrons when heated, while the control grid tends to slow down or repel electrons. The control grid is closest to the cathode and has a negative charge. With a positive charge, the screen-grid accelerates the electrons moving toward the anode. Closer to the anode, the suppressor grid, commonly tied to the cathode, repels or suppresses electrons that are knocked off from the anode (*secondary emission*).

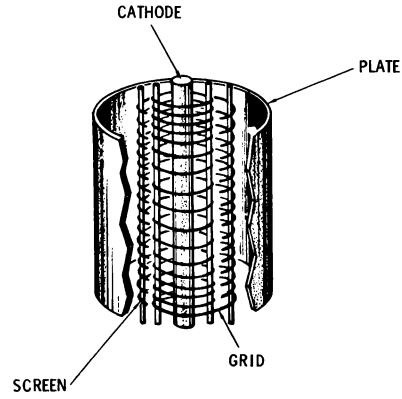


Pentode.

The suppressor grid thus takes on a negative potential with reference to the anode. Pentodes are used for af and rf amplification.

ELECTRON TUBE (TETRODE)

A type of electron tube having four electrodes (cathode, control grid, screen grid, and anode) within a glass- or metal-enclosed vacuum. At the center of the tube, the cathode emits electrons while the control grid, as in the triode electron tube, controls the number of electrons moving toward the anode. Between the control grid and the anode is a second grid referred to as a screen grid. The screen grid serves a dual purpose;

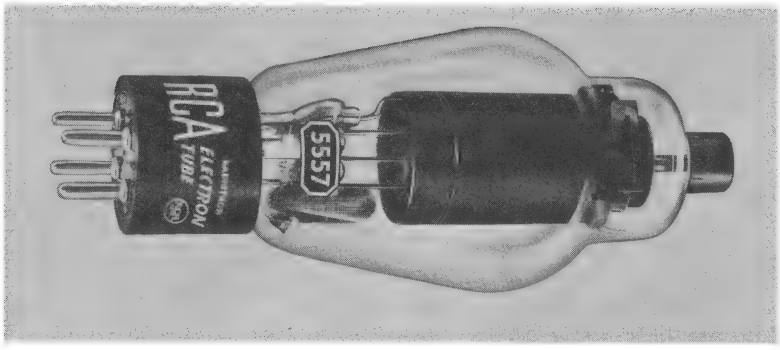


Tetrode.

accelerating the electron movement and reducing the capacitance between the control grid and anode. Accelerating the electrons causes considerable instability in rf amplification. The tetrode is seldom used in modern equipment since the pentode has many advantages with little, if any, extra wiring.

ELECTRON TUBE (THYRATRON)

An electron tube having three electrodes (cathode, grid and anode) within a gas-filled glass or metal enclosure. Up to a fixed value of control-grid voltage, there is no anode current. Beyond the grid voltage value where the thyratron triggers, the grid has no control over the anode current. That is, after the thyratron starts conducting, its control grid cannot increase, decrease, or stop the current. Cur-

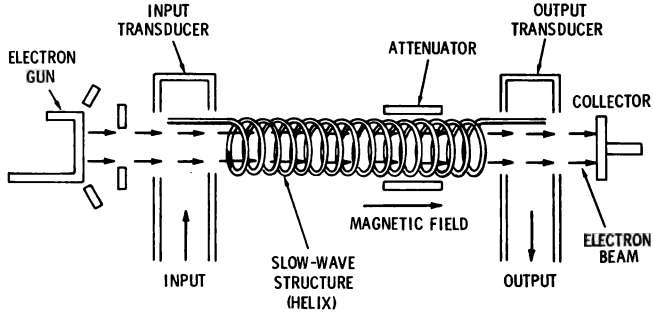


Thyratron.

rent through the thyratron may be stopped only by reducing the anode voltage to zero. Thyratrons are commonly used in relation with both RC time-constants and relays which permit various operations to occur at fixed times and timed intervals. For example, headlights of an automobile may excite a photoelectric cell, causing a thyratron to trigger and start a motor that opens the garage door.

ELECTRON TUBE (TRAVELING-WAVE)

An electron tube used for wide-band microwave-frequency amplification. Unlike the klystron, the traveling-wave tube uses no resonant cavities to limit the frequency bandwidth. As the microwave signal travels along a wire helix within the traveling-wave tube, it gains energy from an electron

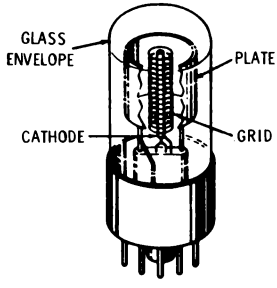


Traveling-wave tube.

beam passing through the center of the helix. The amplified microwave signal then appears at the other end of the wire helix. Traveling-wave electron tubes are used for multichannel microwave communications.

ELECTRON TUBE (TRIODE)

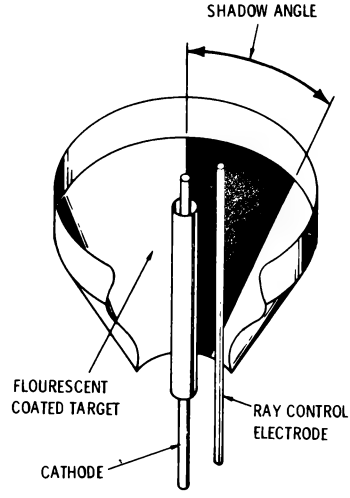
An electron tube having three electrodes (cathode, control grid, and anode) within a glass- or metal-enclosed vacuum. At the center of the tube, the cathode emits negatively charged electrons that are normally attracted toward the anode. But when a grid of very fine wire between the cathode and the anode is negatively charged, the electrons are slowed down or repelled back toward the cathode. Spacing between these grid wires is large enough to permit some electrons to pass through to the anode. But the more negative the control grid is with respect to the cathode, the fewer electrons pass through to the anode. Since the control grid is closer to the cathode than to the anode, the control-grid voltage has the greatest effect upon the electron movement. Amplification is the primary use of the triode electron tube.

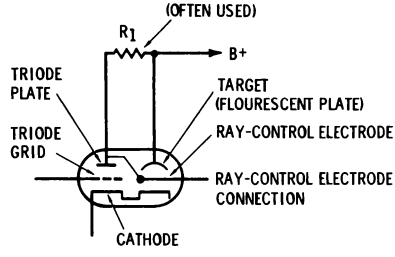


Triode.

ELECTRON TUBE (TUNING-EYE)

An electron tube having a triode-amplifying section combined with





Tuning-eye indicator tube.

a phosphorous target. The output of the triode section puts a varying positive voltage on a ray-controlled electrode. With a positive voltage on the electrode, electrons from the cathode cause a large portion of the phosphorous target to glow. With the grid of the triode connected to an automatic volume control (avc) circuit, the ray-controlled electrode voltage and the resulting angle of target glow are dependent upon the signal level. That is, a strong signal will produce a narrow angle of glow area while a wide angle indicates a weak signal. In this manner, the tuning-eye electron tube can be used to indicate relative signal strength as well as the proper tuning.

ELECTRON TUBE (XENON)

A two element electron tube filled with rare xenon gas. Producing a very intense light, the xenon tube can be used to excite the ruby laser or a beacon light at sea.

ELECTRON TUBE (X-RAY)

An electron tube producing a highly accelerated beam of electrons that will bombard a target and develop X rays. Such X rays will penetrate human flesh as well as metals. Therefore, photographic film opposite the X-ray tube will be exposed.

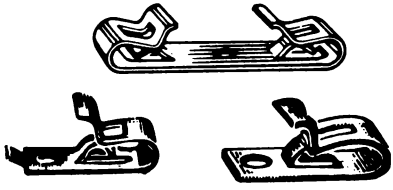
EPITAXIAL TRANSISTOR

See Transistor (Epitaxial)

F

FAHNESTOCK CLIP

A clip gripping a wire by spring action. As a means of temporary connect/disconnect, the Fahnestock clip is quite useful.



Fahnestock clips.

FEEDTHROUGH CAPACITOR

See Capacitor (Feedthrough)

FIELD-EFFECT TRANSISTOR

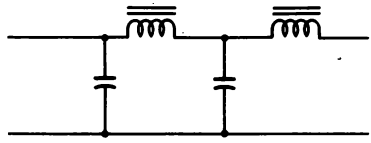
See Transistor (Field-Effect)

FILAMENT TRANSFORMER

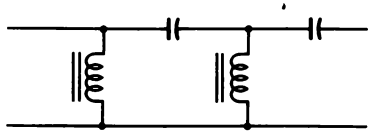
See Transformer (Filament)

FILTER (AUDIO-FREQUENCY)

A circuit or portion of a circuit capable of passing certain audio frequencies. Usually the audio-frequency filter will pass a given band of frequencies while rejecting others. The tone control section of an audio amplifier is often a combination of audio-frequency filters.



Low pass.



High pass.

Audio-frequency filters.

FLEXIBLE COUPLING

See Coupling (Flexible)

FLYBACK TRANSFORMER

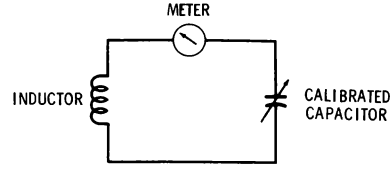
See Transformer (Flyback)

FOCUS COIL

A coil used to develop an electromagnetic field for the purpose of concentrating the electron beam of a cathode-ray tube. For the picture of a television receiver to appear sharp and in focus, the electron beam must converge to a small point on the face of the cathode-ray tube. The focus coil placed about the neck carries direct current and develops a magnetic field that results in the desired focus. In series with the focus coil, a focus control serves to adjust the current to optimum focus.

FREQUENCY METER (ABSORPTION)

A device used to measure the frequency of a signal of more than 200 kHz. The absorption frequency meter consists of an inductor and a capacitor (forming a resonant circuit), a diode (rectifying detector), and an indicating meter. The capacitor is variable and calibrated with regard to frequency. Coupled to the unknown frequency, the capacitor is adjusted until the indicating meter has a maximum reading. The inductor and capacitor is then resonating at the unknown frequency. Reading of the calibrated frequency meter dial gives the frequency.



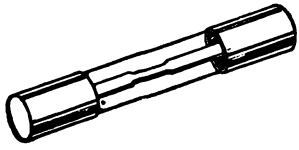
Absorption frequency meter.

FUEL-CELL BATTERY

See Battery (Fuel Cell)

FUSE (FAST-ACTING)

A safety device used in electric and electronic circuits. In all circuits there is a possibility of excess current, causing excessive heat and fire. The fast-acting fuse has a metal element that melts at a low temperature. When the current passing through the fuse reaches the rated value, the resulting heat quickly melts the fuse element.



Fast acting fuse.

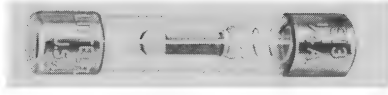
Thus, when the current reaches the rated value of the fuse, the circuit is opened. There are many current ratings, physical shapes, and sizes for fuses. In electronics, the fuses are usually the small cartridge type having the fuse element inside a glass or ceramic tube rated at approximately .125 to 20 amperes. Home and industry electrical mains use larger cartridge type fuses of up to several hundred amperes. The smaller distribution lines within the home are commonly protected by screw-in plug-type fuses having 10, 15, 20, 25 and 30-ampere ratings.

FUSE (INSTRUMENT)

A safety device used with various electrical measuring instruments including voltmeters, ammeters, wattmeters, and others. It is always possible to misjudge the voltage or current of a circuit, as well as to subject a meter to a quantity beyond its capacity, causing damage. Instrument fuses are of the cartridge variety having a metal element that melts in an extremely short time. The ratings for instrument fuses range from .002 ampere to 5 amperes.

FUSE (SLOW-BLOW)

A safety device used in electrical and electronic circuits where a higher than normal initial current may be expected. During the start of an electric motor, for example, the current required to bring it to full speed may be considerably



Slow-blow fuse.

larger than its running or average normal current. If for some reason the motor does not acquire this running speed, the higher starting current could be damaging to the motor. Therefore, a standard fuse rated to withstand the starting current would probably not give ade-

quate protection during abnormal currents. Thus, slow-blow fuses are used to give adequate normal protection as well as let the initial current run above the normal value for a short time.

G

GALVANOMETER (METER)

See Meter (Galvanometer)

GASEOUS PHOTOCELL

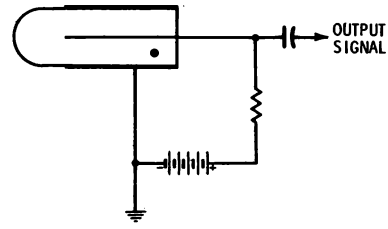
See Photocell (Gaseous)

GASEOUS VOLTAGE-REGULATOR.

See Electron Tube (Gaseous Voltage-Regulator)

GEIGER-MUELLER TUBE

A gas-filled tube having an external metal coating and a thin wire electrode inside; used to determine the presence of X-ray, beta, and gamma radiation. Since X-ray, beta and gamma radiations have adverse effects upon animal and human tissue, it is quite important that such radiations be properly detected. Such radiations enter the tube to ionize its gas and produce pulses of current.



Geiger-Mueller tube.

The number of current pulses is relative to the intensity of the radiation. Upon amplification, these pulses may be applied to headphones, speakers, or some visual indicator.

GERMANIUM DIODE

See Diode (Germanium)

GERMANIUM TRANSISTOR

See Transistor (Germanium)

GENERATOR (SOLAR)

See Photovoltaic Cell

H

HALF-WAVE DIPOLE ANTENNA

See Antenna (Half-wave Dipole)

HALL-EFFECT ELEMENT

A solid-state semiconductor used in measuring the intensity and direction of a magnetic field.

HEADPHONE (CRYSTAL)

A transducer converting electrical waves into sound waves. The crystal headphone has a wafer of piezoelectric material, commonly Rochelle salt, mounted between two metal plates. When an audio-frequency voltage is applied to these two plates, the crystal vibrates. Coupled with a small diaphragm, the vibrations of the crystal become audible sound waves. Crystal headphones will not pass current but are voltage sensitive. Therefore, a coupling capacitor must be used between the amplifier and the crystal headphones. Modern crystal headphones have ceramic elements with electrical and mechanical ruggedness.

HEADPHONE (DYNAMIC)

A transducer converting electrical waves into sound waves. The dynamic headphone has a moving coil located within the field of a permanent magnet. This moving coil, also referred to as the voice coil, is attached to a flexible cone. Audio-frequency current passing through this voice coil produces a varying magnetic field, causing the coil and flexible cone to move and develop audible sound waves. Dynamic headphones have low impedances, 4 to 16 ohms, and commonly must be coupled to an amplifier through an output transformer. With a wide frequency response and good fidelity, dynamic headphones are often used for private listening to high-fidelity music. Dynamic headphones are also available for stereophonic listening.

Dynamic headphone.

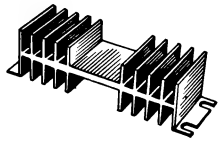
HEADPHONE (MAGNETIC)

A transducer converting electrical waves into sound waves. The

magnetic headphone has two coils of many turns of fine wire wound about the poles of a horseshoe-shaped magnet. An audio-frequency current passing through these two coils develops a varying magnetic field that reacts with the permanent magnetic field. The resulting magnetic field causes the diaphragm to vibrate and produce audible sound waves. With coil impedances around 2000 ohms, the magnetic headphone can be used directly in the plate circuit of a tube amplifier or in the collector circuit of a transistor amplifier. However, the magnetic headphone has a limited frequency response.

HEAT SINK

A finned, metal plate or block used to carry heat away from solid-state devices such as transistors and diodes. Most solid-state devices are sensitive to temperature changes. Transistors for example, tend to pass more current as their temperature increases. Since a larger current creates additional temperature, the process can become an avalanche situation with the transistor or diode burning out. To prevent this, the solid-state device is attached to a heat sink so that much of the heat developed is radiated away. Solid-state devices developing less than .5 watt can usually radiate heat well enough without a heat sink.



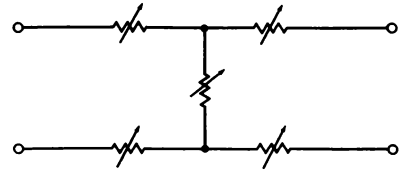
Heat sink.

HOT-WIRE METER

See Meter (Hot-Wire)

H-PAD

A combination of five variable resistors arranged in the configuration of a letter H to control the amount of power delivered to a load. Built on a single shaft, the values of these five resistors are fixed to maintain their input and output impedance at stated levels.



H-pad.

I

IMAGE ORTHICON

See Electron Tube (Image Orthicon)

INDUCTOR COIL

Any of a number of coiled conductor devices used to put inductance into a circuit. Since inductance opposes any change in current, the inductor provides such opposition when used in a circuit. The opposition presented by the inductor is a reactance rather than a resistance, because it is the resultant effect of current. Inductor coils are of many types including multiple-layered windings, single-layered windings, pi-wound, laminated-iron core, powdered-iron core, slug-tuned, and air-core.

INDUCTOR (POWER-SUPPLY CHOKE)

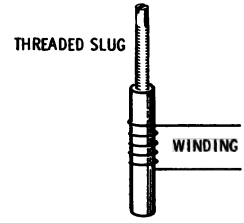
See Choke (Power-Supply)

INDUCTOR (RADIO-FREQUENCY CHOKE)

See Choke (Radio-Frequency)

INDUCTOR (SLUG-TUNED)

An inductor with a movable ferrite (powdered-iron) core. With the windings wound on a phenolic or other insulating form, the core is arranged with threads so that some of the core is within the magnetic path of the coil. As the core (slug) is screwed into the magnetic path, the inductance of the



Slug-tuned inductor.

coil is increased. Conversely, inductance is decreased as the core is screwed out, away from the magnetic path. This gives the slug-tuned inductor a considerable range of inductance and of usage. Slug-tuned inductors are used in rf oscillators, i-f circuits and traps, loopstick antennas, and various pulse oscillators or generators.

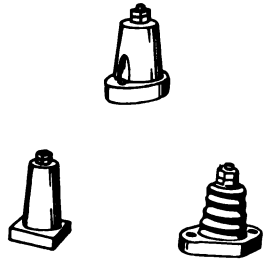
INSULATOR (ANTENNA)

Any of a number of different devices used to insulate one portion of an antenna from another, or the antenna from its supporting structure. Most commonly used with long-wire type antennas, the antenna insulator is not often seen with modern equipment. However,

the modern antenna does often use insulators for spacing, as with the half-wave dipole, or for support, as with the whip-type antenna found on automobiles and other vehicles.

INSULATOR (CONE)

A cone-shaped insulator commonly made of white, glazed porcelain. These are commonly stand-



Cone insulator.

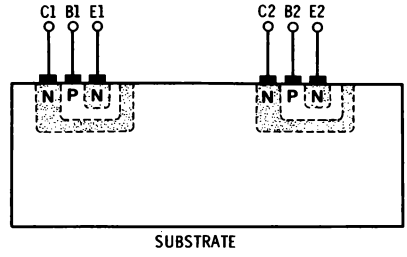
off insulators used to support electrical components and conductors above or away from some other object.

INSULATOR (GUY-WIRE)

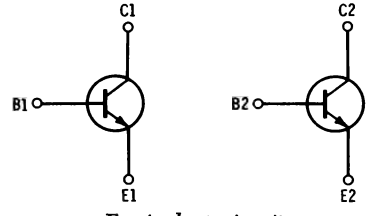
A rather large, porcelain insulator used with guy-wires for supporting antenna towers or masts. To eliminate the possibility of the guy-wires having adverse effect upon antenna, it is common practice to divide each guy-wire into different lengths. Between each of these lengths a guy-wire insulator is used.

INTEGRATED CIRCUIT

A solid-state device encompassing a complete electronic stage or circuit. The integrated circuit is built upon a block or chip of semiconductor material (usually silicon) known as the substrate. Various layers of p and n-type materials are then built upon this substrate while an etching process forms different configurations into the layers. In the completed chip, the various areas serve as transistors, diodes, resistors, and capacitors. With interconnections and leads attached to these areas and sealed into a container, the integrated circuit can be used in many ways. Integrated circuits are available as dc amplifiers, audio-frequency amplifiers, flip-flop circuits,



Chip.



Equivalent circuit.

Integrated circuit.

and various computer circuits. However, a more complicated audio-amplifier, integrated circuit, could contain 11 transistors, 6 diodes, 18 resistors with gains of 10, 20, 100 and 200.

INTEGRATED-CIRCUIT SOCKET

See Socket (Integrated-Circuit)

INTERCOM

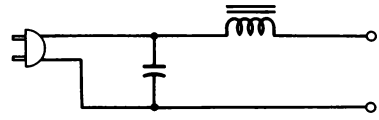
An audio amplifying system used for communication between offices, office and shop, or various rooms of a home.

INTERCOM (WIRELESS)

A form of intercom (intercommunications) system using existing power lines to carry audio signals between stations. A station consists of a transmitter, and a receiver. The transmitter develops an rf signal with a frequency ranging from 50 to 200 kHz modulated by the audio signal that is coupled into the power line. Receivers of other stations receive, amplify, and demodulate the rf signal from the power line.

INTERFERENCE FILTER

A circuit designed to eliminate interfering electrical variations from the power line. Quite often neon



Interference filter.

advertising signs, flourescent lights, and electric motors produce voltage and current irregularities that travel along the power lines to cause interference in electronic equipment. Such interference appears as irritating popping and cracking noises (static) in radio receivers and as rolling, distorted pictures in television receivers. Much of this interference is a high multiple of the 60-Hz power frequency that can be reduced considerably by an interference filter. Being a low-pass filter, the interference filter in its simplest form a large capacitor across the power line. Better interference filters also have inductances in series with the power line.

INTERVAL TIMER

A clock actuated switch establishing the length of time during which a circuit is closed or opened. For the shorter time intervals tube or transistor circuits can replace the clock. *Also see Relay (Time Delay).*

INVERTER

A device converting low-voltage direct current to high-voltage alter-

Inverter.

nating current. Motor-generator inverters have a dc motor driving an ac generator while a vibrator and transformer arrangement constitutes an electromechanical type inverter. Transistors, silicon controlled rectifiers, and transformers can be arranged together and used as another type of inverter.

IRON-VANE METER

See Meter (Iron-Vane)

INSTRUMENT FUSE

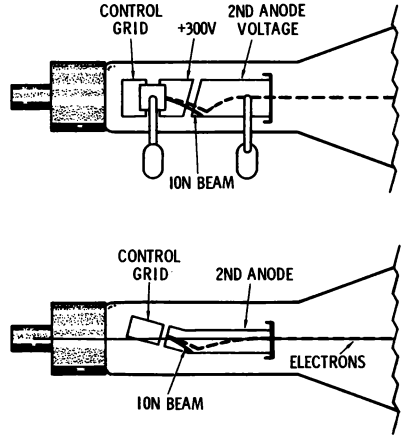
See Fuse (Instrument)

INSULATED COUPLING

See Coupling (Insulated)

ION TRAP

A device used on a cathode-ray tube to divert negative ions and thereby prevent their burning a spot on the screen, but still permitting the electrons to flow toward the screen.



Ion trap.

J

JACK (BANANA)

A chassis- or panel-mounted connector to receive a banana plug. The banana jack is a single contact device consisting primarily of a metal sleeve into which the banana plug fits and has an insulated or uninsulated mounting.

JACK (MICROPHONE)

A chassis- or panel-mounted connector to receive microphone

or earphone plugs. The single opening of the microphone jack has two or three spring contacts that may also act as switches when the plug enters.

JACK (PHONE)

See Jack (Microphone)

JACK (PHONO)

A chassis- or panel-mounted connector to receive the straight pin plug of a single-conductor, shielded, phono cable. Phono jacks commonly fit 1/4 inch mounting holes and have a small collar making contact with the plug and the shield of the cable.

JACK (TIP)

A chassis- or panel-mounted connector to receive the straight, unshielded tip plug. Tip jacks are commonly used with meters and testing instruments.

JEWEL BEARING

A natural or synthetic sapphire used as the bearing at pivot points of electrical meters. Such sapphire bearings have a hardness to withstand the continuous wear without becoming misaligned.

JONES PLUG

See Plug (Jones)

JUMPER

A temporary bypass of a circuit, or component. The jumper usually consists of a short length or wire connected between two points.

JUNCTION BOX

A box used to house the connections of two or more cables. Usually found in power distribution systems, the junction box provides an enclosed and shielded place for joining longer cable lengths as well as for branching off of other cables from the main circuit. Only larger complex electronic systems would have need for junction boxes.

K

KLYSTRON

See Electron Tube (Klystron)

L

LAMP (MINIATURE INCANDESCENT)

A small lamp having a continuous filament of tungsten wire. With voltage ratings from 2.3 to 120 volts, these miniature incandescent lamps are small enough to illuminate such items as tuning dials and meters. They have varied bulb shapes and base types including bayonet, screw, wire lead, and spring contact.

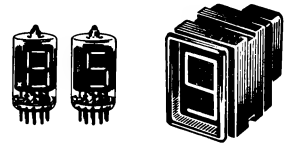
LAMP (NEON)

A lamp having two electrodes within a gas-filled bulb. Application of a minimum voltage of approximately 65 volts to the two electrodes of the neon lamps ionizes the neon gas and produces an orange glow. The voltage required for this ionization is dependent upon the electrode spacing and the gas pressure.

Neon lamp.

LAMP (READOUT)

A lamp providing a visual representation of a numeral or letter. The simplest form of readout lamp consists of an incandescent lamp behind a miniature window having the shape of a numeral or letter.



Readout lamp.

Another type of readout lamp has one common electrode and a series of other electrodes having the shapes of the following numerals: 1, 2, 3, 4, 5, 6, 7, 8, 9 and 0. When a voltage is applied between the common electrode and one of the shaped electrodes, a glowing image of that electrode numeral is produced. *Also see Diode (Light-Emitting).*

LAMP SOCKET

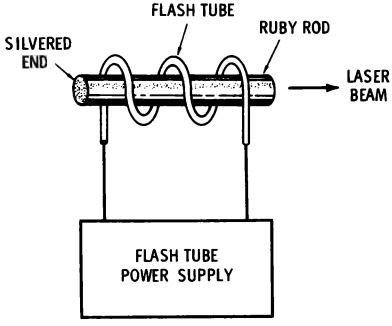
See Socket (Lamp)

LAMP (ULTRAVIOLET)

A lamp radiating ultraviolet light having wavelengths between 200 and 4000 angstrom units. Mercury vapor lamps, carbon-arc lamps, and specially treated glass incandescent lamps emit ultraviolet light. Ultraviolet lamps are used in photographic and photochemical processes and are thought to have some therapeutic value.

LASER (RUBY)

Generator of a high-intensity coherent light beam. While visible light is a mixture of light waves traveling out-of-phase in all directions, the laser is a beam of light waves in-phase and traveling in straight, parallel lines. The laser beam is said to be coherent since it can travel great distances without appreciable spreading. A laser beam is produced as an intense flash of light introduced into a ruby rod. With one end of the ruby rod silvered, the laser beam is emitted from the opposite end. The laser beam is presently being used in communications and medical techniques and is thought to hold many promises for the future. *Also see Diode (Light-Emitting) and Electron Tube (Xenon).*



Ruby laser.

LATCHING RELAY

See Relay (Latching)

LEAD-ACID BATTERY

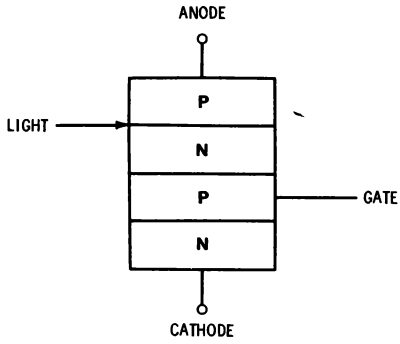
See Battery (Lead-Acid)

LEVER SWITCH

See Switch (Lever)

LIGHT-ACTIVATED SILICON CONTROLLED SWITCH

A solid-state device that becomes conductive when exposed to light. The light-activated silicon controlled switch (LASCS) has four alternate layers of p-type and n-type material. Any applied voltage will make one of the three junctions reverse-biased and no current will pass through the LASCS. But when the reverse-biased junction is illuminated, the charge barrier is broken and current begins to flow. Once current starts flowing it can only be stopped by turning



Light-activated silicon controlled switch.

off the supply voltage or by introducing a counter voltage into one of the center sections known as the gate.

LIGHTNING ARRESTER

See Arrester (Lightning)

LONG-WIRE ANTENNA

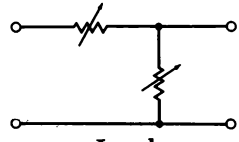
See Antenna (Long-Wire)

LOOPSTICK ANTENNA

An inductor coil used as a standard-broadcast receiving antenna. With a ferrite (powdered-iron) core, the high Q loopstick has excellent signal pickup. Being very directional, the loopstick antenna must be turned in proper direction to receive a maximum signal. Most portable standard-broadcast receivers use loopstick antennas.

L-PAD

Two ganged, variable resistors arranged in an inverted L configuration and used to control the amount of power applied to a speaker from an audio amplifier. The L-pad provides a constant level of impedance to both the amplifier and speaker.

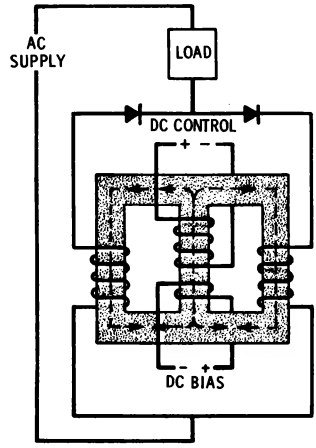


L-pad.

M

MAGNETIC AMPLIFIER

A variable-impedance device used for the amplification of an electrical signal. The magnetic amplifier has two or more windings on a magnetic core that is easily saturated with one winding being used to control the degree of saturation. As the magnetic saturation varies, the permeability of that magnetic core also varies. With these variations in saturation and permeability, there is also a variation in the inductance values of the load windings. A small current



Magnetic amplifier.

variation in the first winding causes a change in inductance and a large change in current through the load windings. In other words, the small current variation produces a much larger load-winding current. In this manner, the magnetic amplifier increases or amplifies the current.

MAGNETIC CIRCUIT-BREAKER

See Circuit-Breaker (Magnetic)

MAGNETIC-REED SWITCH

See Switch (Magnetic-Reed)

MAGNETORESISTOR

A semiconductor that changes its resistance value when subjected to a magnetic field.

MAGNETRON

See Electron Tube (Magnetron)

MAGNET WIRE

A form of copper wire used for the winding of electromagnetic devices such as transformers, inductors, chokes, and rf coils. Magnet wire has sizes ranging from No. 14 to No. 40 and is insulated with silk, cotton, or enamel.

MERCURY BATTERY

See Battery (Mercury)

MERCURY SWITCH

See Switch (Mercury)

MERCURY-VAPOR DIODE

See Diode (Mercury-Vapor)

MESA TRANSISTOR

See Transistor (Mesa)

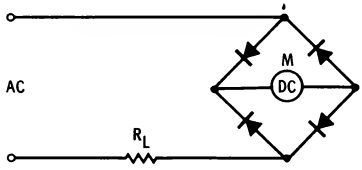
METER (AMMETER)

See Ammeter

METER (AC VOLTMETER)

A meter used for the measurement of alternating current or volt-

Typical ac voltmeter.



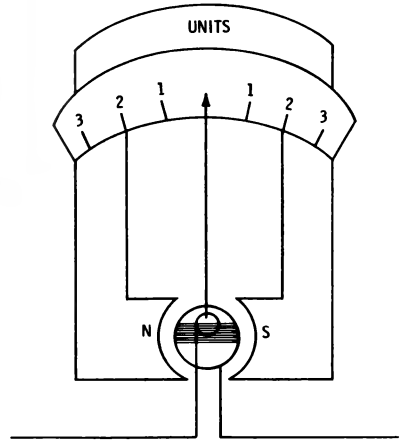
Basic circuit.

Ac voltmeter.

age. With a D'Arsonval movement, copper-oxide or silicon diodes are used to rectify the alternating current into direct current. The meter normally shows the effective, or rms, value of an alternating sine wave.

METER (D'ARSONVAL)

The basic form of the working element or movement used in ammeters, milliammeters, voltmeters, and ohmmeters. Basically, the construction of a D'Arsonval meter is a small coil of wire suspended between the poles of a permanent magnet. The coil and an associated pointer is suspended by small rods and jeweled bearings. Hairsprings serve as conductors to the coil as well as holding the coil and its pointer at the normal zero position.

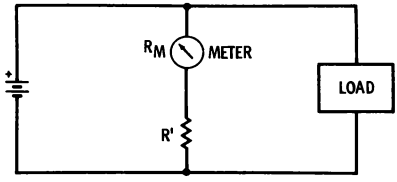


D'Arsonval meter.

When a current passes through the coil, its magnetic field reacts with the field of the permanent magnet and causes the coil assembly to rotate. Rotation of the coil and associated pointer is controlled by the hairsprings and is proportional to the current. A calibrated scale may be placed behind the pointer to indicate different current values. The D'Arsonval meter will respond to direct current only, therefore rectifying diodes must be added for alternating current usage.

METER (DC VOLTMETER)

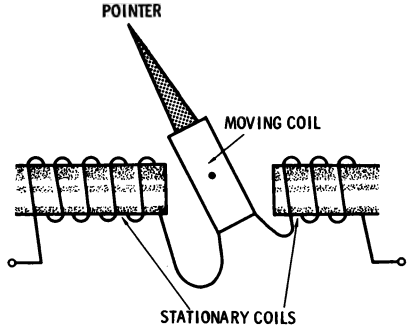
A meter used for the determination of dc voltages. The voltmeter consists of a dc current meter in series with a known resistance standard. Since this resistance will pass a known current when a given voltage is applied, the meter can be calibrated to read in volts. That is, when the resistance of 100 ohms passes a current of 15 mA, the voltmeter can be calibrated to read 1.5 volts. Different values of resistance standards may be used to give the voltmeter different ranges.



Dc voltmeter circuit.

METER (DYNAMOMETER)

A basic form of meter movement used for either direct or alternating current. The dynamometer differs from the D'Arsonval movement by having a fixed coil instead of a permanent magnet. Since the same current (direct or alternating) passes through both the fixed coil and the moving coil, the magnetic field between the two coils is always equal and opposing. This does not mean that the magnetic field of the fixed coil is equal to that of the moving coil, but the resultant field is always equal. With alternating current, the resultant magnetic field and resulting rotation will increase and decrease proportionally with the current. Dynamometers may have



Dynamometer.

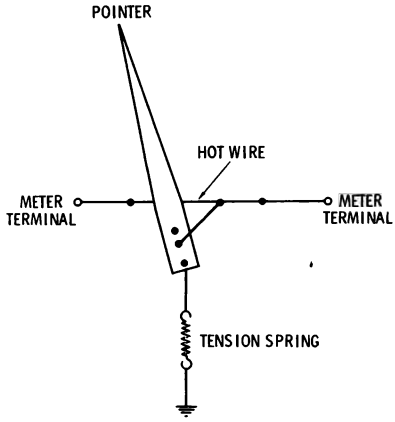
full-scale ratings as high as 5 amperes, or up to 25,000 amperes when current transformers are used. With smaller windings and series resistors, the dynamometer can be used as a voltmeter having full scale ratings from 5 to 150 volts. By wiring the fixed coil in series with a circuit and the moving coil in parallel, the dynamometer becomes a wattmeter.

METER (GALVANOMETER)

With the hairsprings replaced by a long ribbon, the galvanometer is a very sensitive form of the D'Arsonval movement. Galvanometers show only relative values and are not calibrated in voltage, current, or resistance.

METER (HOT-WIRE)

A meter using the expansion of a heated wire as its working element. As current passes through the wire made of special alloy, the heat developed causes the wire to expand. The pointer of the meter is attached to the hot, expanding

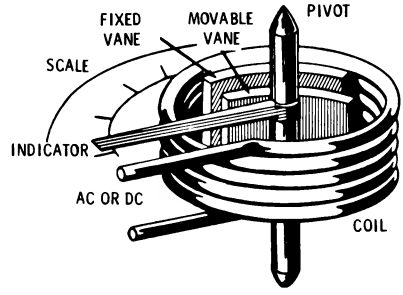


Hot-wire meter.

wire so that that pointer will rotate as the wire expands. Since the expansion of the wire is increased with an increase in current, the rotation of the pointer is also increased as the current increases. In addition to responding to both direct and alternating current, the hot-wire meter is also useful in measuring radio-frequency energy.

METER (IRON-VANE)

A meter using the repulsion of two magnetized iron-vanes as its rotating force. A stationary and movable vane of soft iron is placed within a current carrying coil. Direct or alternating current will magnetize the two iron vanes in the same direction. That is, the north end of the stationary vane is adjacent to the north end of the



Iron-vane meter.

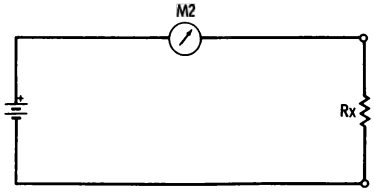
moving vane, and they will tend to repel each other. As the moving vane is repelled away from the stationary vane, the attached pointer moves across the scale. Iron-vane meters are reasonably accurate for direct current and for alternating current up to 400 Hz.

METER (MILLIAMMETER)

A meter used for the measurement of current in the milliampere range. The basic milliammeter has a D'Arsonval movement and a full-scale rating of 1.0 mA. Then various meter shunts are used to extend this basic meter to higher ratings. Diodes must be added for use with alternating current.

METER (OHMMETER)

A meter used for the determination of resistance. The ohmmeter consists of a dc current meter and a voltage standard. Since this voltage standard will produce a known current through a given resistance, the meter then can be calibrated to read in ohms. That is, when a voltage standard of 1.5 volts produces a current of 15 mA, the ohmmeter can be calibrated to read 100 ohms. Various series and shunt resistors may be added to extend the range of the ohmmeter from about 1.0 ohm to 100 megohms.



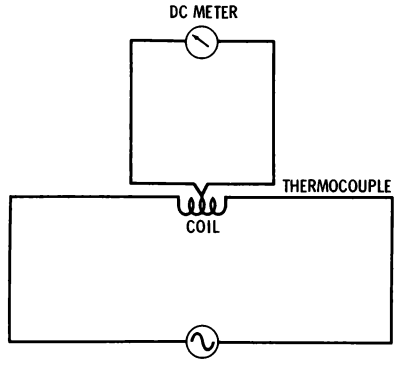
Ohmmeter circuit.

METER (S-METER)

A meter indicating the relative signal strength received by a receiver. Found in communications receivers, S-meters measure the rectified voltage or current used for automatic volume control.

METER (THERMOCOUPLE)

A meter used for the measurement of rf current in transmitters and antennas. Thermocouple meters have a heating coil producing a temperature change detected by a bimetallic junction. The bimetallic junction is referred to as the thermocouple and when heated develops a voltage proportional to the



Thermocouple meter circuit.

heat. The heat then is proportional to the square of rf current. Therefore, the voltage developed by the thermocouple is proportional to the square of the rf current indicated by the D'Arsonval movement across the thermocouple. For example, two amperes of rf current would show as four amperes of dc current on the meter. Most thermocouple meters are calibrated to read directly for low- or radio-frequency currents.

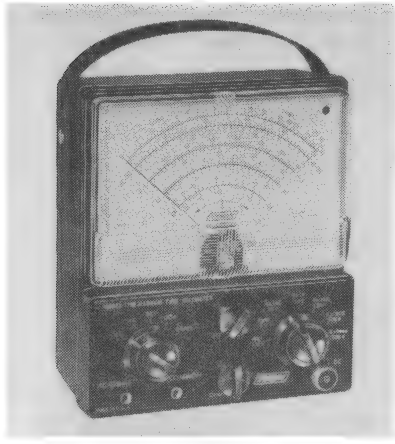
METER (TRANSISTOR VOLTMETER)

An instrument used for measuring ac and dc voltage as well as current and resistance. The tran-

sistor voltmeter uses the amplification and rectification by transistors to develop a dc current proportional to the applied voltage.

METER (VACUUM-TUBE VOLTMETER)

An instrument used for the determination of audio- and radio-frequency voltages. The vacuum-tube voltmeter makes use of the amplification and rectification by pentode and triode electron tubes to develop a dc current proportional to the applied voltage. Vacuum-tube voltmeters have a very high input impedance, and accordingly have little effect upon a circuit.



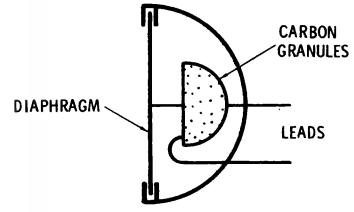
Vtvm.

MICA CAPACITOR

See Capacitor (Mica)

MICROPHONE (CARBON)

A transducer changing the varying pressures of a sound wave into electrical variations. Sound pressures act upon the diaphragm to change the density of the carbon granules. An increase in the carbon-granule density decreases its resistance, which in turn permits a larger current to flow. Conversely, a decrease in the sound-wave pressure decreases the current passed through the microphone. The resulting wave of current has variations corresponding with those of the sound wave. Unlike other types of microphones, the carbon microphone does not develop its own voltage. With a high noise level, distortion, and a limited frequency response, the carbon microphone is used primarily for voice communications in telephones and electronic megaphones.



Carbon microphone.

MICROPHONE (CERAMIC)

A transducer changing the varying pressures of a sound wave into electrical variations. The ceramic microphone has a wafer of ceramic

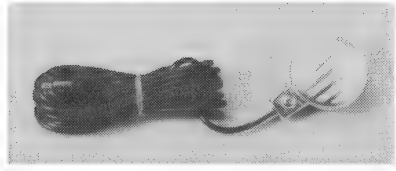
material mounted between two plates. Linked with a diaphragm, sound pressures cause mechanical stresses on the ceramic wafer. Such stresses on a ceramic wafer develop an electrical potential between the two plates. Thus, the voltages developed between the two mounting plates are proportional to the sound-wave pressures. With good frequency response, a ceramic microphone has outputs ranging from −60 to −50 dBm (dBm = 0.001 watt across 600 ohms).

MICROPHONE (CONDENSER)

A transducer changing the varying pressures of a sound wave into electrical variations. The condenser or capacitor microphone has a diaphragm acting as one plate of a capacitor. Sound waves striking this diaphragm produce a variation of capacitance between that diaphragm and a stationary second plate. Such capacitance variations can be transformed into frequency or voltage variations. Condenser microphones have very low outputs and commonly have a one- or two-stage amplifier built into the same case. The frequency response is excellent for the condenser microphone and its distortion is very low.

MICROPHONE (CRYSTAL)

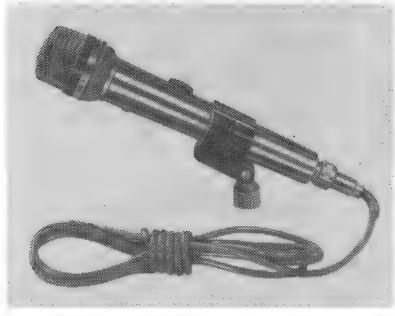
A transducer changing the varying pressures of a sound wave into electrical variations. Much like the ceramic microphone, the crystal microphone has a wafer of piezoelectric material (Rochelle salt) between two metal plates. The crystal microphone also has a good frequency response and output levels from −60 to −50 dBm.



Crystal microphone.

MICROPHONE (DYNAMIC)

A transducer changing the variations of sound-wave pressure into electrical variations. A small coil is attached to the diaphragm of the dynamic microphone and set within the field of a permanent magnet. Sound waves striking the diaphragm move the coil within the magnetic field to electromagnetically induce voltage. Voltages in-

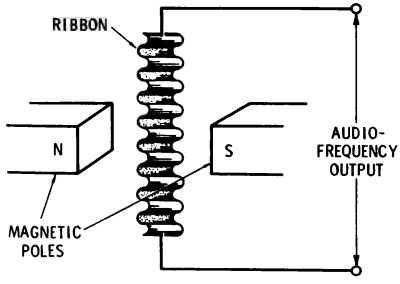


Dynamic microphone.

duced in this manner correspond to those of the sound wave. Dynamic microphones have low output levels (−80 dBm) and a frequency response up to about 15 kHz.

MICROPHONE (RIBBON)

A transducer changing the varying pressures of a sound wave into electrical variations. The ribbon microphone has a thin ribbon of corrugated aluminum placed between strong magnetic poles. The velocity of the sound wave causes ribbon movement. For this reason, the ribbon microphone is also referred to as the velocity microphone. Ribbon microphones are fairly rugged, but movement during operation excites the ribbon and produces unwanted noise. The frequency response for the ribbon microphone is excellent and its output level is low.



Ribbon microphone.

MICROPHONE (WIRELESS)

A microphone not requiring a cable for connection to other equipment. The wireless microphone commonly has a ceramic, crystal, or dynamic microphone modulating a radio-frequency oscillator. The modulated signal from this low-power oscillator radiates to a nearby receiver where demodulation and amplification can take place. Wireless microphones are used in dramas and stage presentations where microphone cables are too limiting.

MIDRANGE (SPEAKER)

See Speaker (Midrange)

MILLIAMMETER

See Meter (Milliammeter)

MINIATURE INCANDESCENT LAMP

See Lamp (Miniature Incandescent)

MODULE

A solid-state circuit or portion of a circuit built upon a printed-circuit board with provision for

quick disconnect from other portions of circuit. These modulars, or circuit sections, are used in the latest television receivers to facilitate faster repair. As the trouble is determined to be within a given section, the module can be quickly removed and a new module put in its place.

MULTISECTION VACUUM TUBE

See Electron Tube (Multisection)

N

NEON LAMP

See Lamp (Neon)

NICKEL-CADMIUM BATTERY

See Battery (Nickel-Cadmium)

NUVISTOR

See Electron Tube (Nuvistor)

O

OHMMETER

See Meter (Ohmmeter)

P

PAPER CAPACITOR

See Capacitor (Paper)

PENTAGRID-CONVERTER VACUUM TUBE

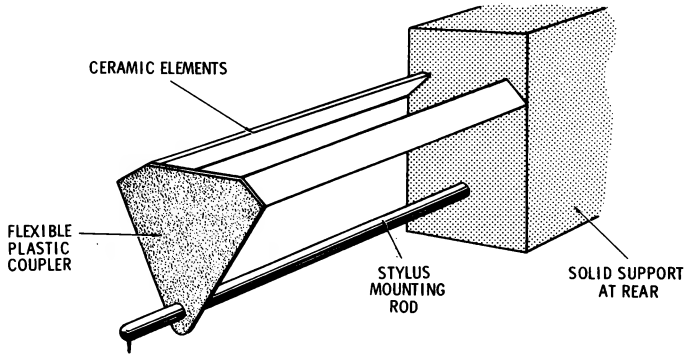
See Electron Tube (Pentagrid-Converter)

PENTODE VACUUM TUBE

See Electron Tube (Pentode)

PHONO CARTRIDGE (CERAMIC)

A transducer used to change the variations within a recording groove into electrical variations.



Ceramic phono cartridge.

As the needle encounters variations in the recording groove, the ceramic slice will be physically distorted. The distortion produces a voltage, up to 3.0 volts, which is proportional to the groove variations and to the original sound wave. The ceramic phono cartridge has a very high impedance and covers the entire audio-frequency range.

PHONO CARTRIDGE (CRYSTAL)

A transducer used to change the variations within a recording groove into electrical variations. The crystal phono cartridge is similar to the ceramic phono cartridge except for the use of a slice of crystal rather than ceramic. The crystal material is commonly that of Rochelle salt. Electrically, the crystal phono cartridge is also much the same as the ceramic phono cartridge.

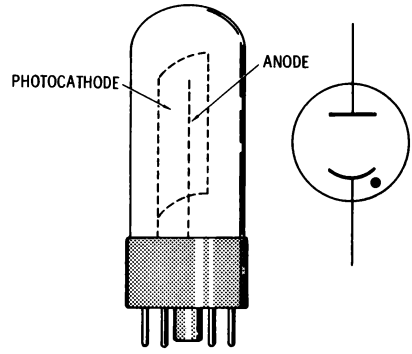
PHONO CARTRIDGE (STEREO)

A transducer used to change the variations within a stereo-recording groove into electrical variations. The stereo recording has both lateral side and vertical bottom variation. With two ceramic or crystal elements mounted at right angles to each other and at an angle of 45° to the needle, the stereo-phono cartridge develops the two voltage waves equivalent to the two sound waves.

PHOTOCELL (GASEOUS)

An electron tube having a cathode that emits electrons when illuminated. The gaseous photocell has a light-activated cathode and a centrally mounted wire anode in a gas-filled envelope. An electron emitted from the cathode will move toward the positively charged anode. However, in traveling through

the gaseous medium, ions are formed with the result that more electrons move to the anode. Thus, the gaseous photocell is more sensitive (a given light intensity produces greater anode current) than the vacuum-type photocell. The gaseous photocell has many industrial and commercial uses.



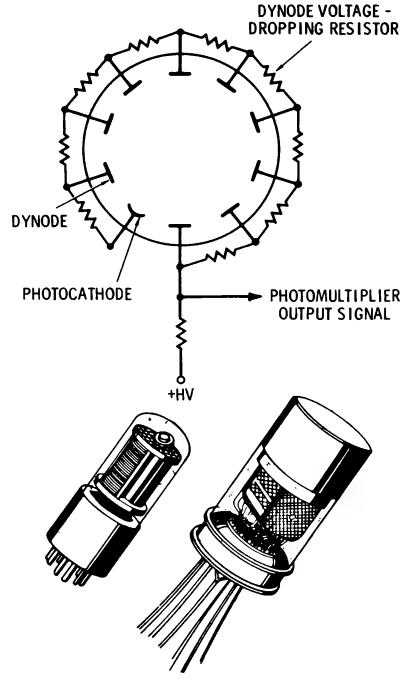
Gaseous photocell.

PHOTOCELL (VACUUM)

An electron tube having a cathode that emits electrons when illuminated. The vacuum photocell has a light-activated cathode and a centrally mounted wire anode within a vacuum. Electrons emitted from the cathode will move toward the positively charged anode. The vacuum photocell is less sensitive than the gaseous photocell.

PHOTOCELL (PHOTOMULTIPLIER)

A highly sensitive electron tube having a light-activated cathode. The photomultiplier has a photosensitive cathode and a number of anodes or dynodes. Each dynode has a voltage that is progressively more postive with respect to the cathode. The cathode and all of the dynodes are arranged in a circle. Electrons emitted from the cathode are attracted to the first adjacent dynode. Secondary emission occurring at the dynode releases additional electrons which are attracted to succeeding dynodes. Each dynode emits more electrons than the succeeding dynode and

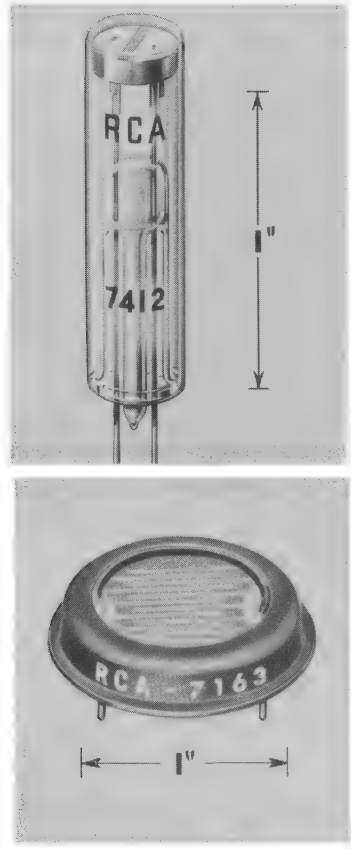


Photomultiplier.

the final may receive up to a million times as many electrons as the first dynode. Thus, the photomultiplier may give a multiplication of one million or more and responds to very low levels of illumination. Such multiplication makes the photomultiplier usable for such applications as astronomical measurements.

PHOTOCELL (PHOTORESISTIVE AND PHOTOCONDUCTIVE)

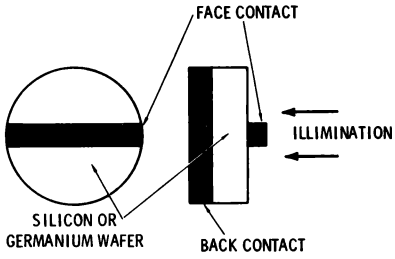
A solid-state device having a decreasing resistance when illuminated. Referred to as either a photoresistive or photoconductive cell, its active elements are cadmium-sulfide or cadmium-sulfo-selenide. Illumination reduces the resistance of these elements and makes them more conductive. In total darkness a photoconductive cell may have a resistance of 10 megohms but have less than 300 ohms one foot from a 75-watt lamp. In a modern camera, a photoconductive cell is used to control transistor currents, and in turn the current through a solenoid. The solenoid then magnetically controls the camera lens opening as well as completing the flash bulb circuit for low light levels.



Photoconductive cells.

PHOTOCELL (PHOTOVOLTAIC)

A solid-state device converting light into electrical energy. The photovoltaic cell consists of a thin wafer of selenium or silicon with its back surface completely silvered. Light waves entering the selenium wafer force electrons to move toward the exposed (front) surface. With a silicon wafer, the electron movement is toward the rear surface. Accordingly, the photovoltaic cell is capable of supplying electrical energy when exposed to light. Communication satellites

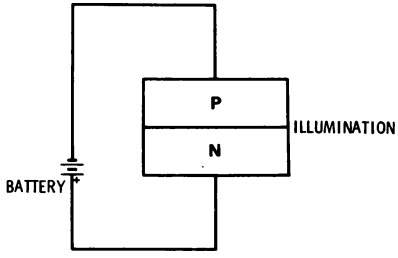


Photovoltaic photocell.

and other electronic equipment are operated in remote locations by such photovoltaic cells.

PHOTOCELL (SILICON DIODE)

A point-contact or junction semiconductor having its reverse-biased resistance decrease when illuminated. Operated in the reverse-biased condition, little or no cur-



Silicon diode photocell.

rent flows through the diode. However, illumination breaks down the normal charge barrier and allows a greater amount of current to flow. Because the seeing area of photocell diodes can be extremely small, they can be used for punch-card and tape read-outs as well as other computer processes.

PHOTOMULTIPLIER (PHOTOCELL)

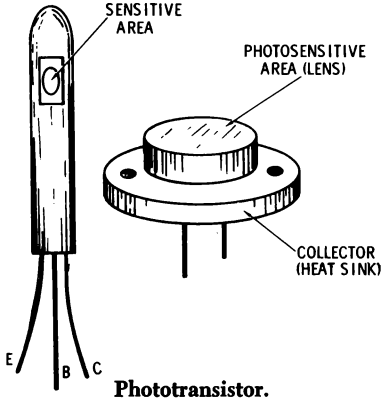
See Photocell (Photomultiplier)

PHOTORESISTIVE (PHOTOCELL)

See Photocell (Photoresistive and Photoconductive)

PHOTOTRANSISTOR

A solid-state device passing an increased amount of current when illuminated. The transistor photocell is referred to as a transistor because of its three-crystal section. However, there is no electrical connection. In effect, the light falling upon the base area serves the same purpose as the base current in a regular transistor. That is, light shining upon the base area breaks down the charge barrier at the base-emitter and base-collector



Phototransistor.

junction. Therefore, the collector current is dependent upon the level of illumination.

PIEZOELECTRIC CRYSTAL

A transducer element capable of changing mechanical or light energy into electrical energy. Quartz and Rochelle-salt crystals are natural types of piezoelectric materials while ceramic materials are synthetic types. All such crystalline materials contain three axes: light, mechanical, and electrical. Light acting along the light axis of the crystal produces mechanical and electrical vibrations along their respective axis. In turn, mechanical vibrations along the mechanical axis gives light and electrical vibrations. The quartz crystal has mechanical vibrations relative to its mass and thickness. Accordingly, when a quartz crystal is placed between two metal plates in line with its electrical axis, an electrical pulse will start mechanical vibrations with a fixed frequency. By reaction, the mechanical vibrations produce electrical vibrations having that same fixed frequency. Thus, the quartz crystal functions as a parallel resonant circuit and as a frequency-determining element. Rochelle-salt crystals and ceramic elements are used primarily as the basic components of microphones and phono cartridges.

PLATE-CIRCUIT RELAY

See Relay (Plate-Circuit)

PLUG (AC POWER)

A connector used on the end of an ac power cord. The ac power plug consists of two flat prongs measuring $1/4 \times 5/8$ inch and spaced 1/2 inch apart. For polarizing purposes, some plugs have one prong slightly larger than the other, and still other plugs have a third round prong giving additional grounding.

PLUG (BANANA)

A single prong, single conductor plug used for quick and temporary connections. With bowed spring contact sides, the banana plug has a larger diameter at the center of its prong, somewhat like a banana. This spring action assures good electrical contact regardless of vibrations. The banana plug is often used with test instruments and meters.

PLUG (JONES)

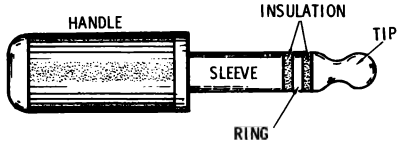
A receptacle type connector with either male or female contacts. The Jones plug is often used between chassis or units of a system. It is keyed and polarized so that wrong connections cannot be made.

PLUG (MICROPHONE)

A single- or double-contact plug with a shield for the connection of microphone cables. The microphone plug has a metal case and lock-nut to match the threaded chassis connector and one or two bead-shape contacts.

PLUG (PHONE)

A single-pronged type plug having tip, ring, and sleeve sections separated by insulated rings. Upon entering the phone jack, the phone plug makes contact with a different portion of the jack. The phone plug may also push other contacts of the jack aside to make or break various circuits. A majority of the phone plugs are used with headphones and have only the tip and sleeve sections.



Phone plug.

PLUG (PHONO)

A small single-pronged plug having a spring-loaded, cuplike shield. Used with single-conductor cable, the inner conductor is pushed through the hollow prong and soldered at the tip while the cup is soldered to the cable shield. The phono plug is used primarily to connect a phonograph turntable to its amplifying system.

PLUG (TELEPHONE)

A four-pronged plug for use with the standard three- or four-conductor telephone system. Telephone plugs and jacks provide mobility of telephones from one room to another.

PLUGS (PATCH)

A two-pronged plug having tip and sleeve sections. Patch plugs are attached to each end of a length of shielded two-conductor cable to form a *patch cord.* Patch cords and a panel of matching jacks provide a system for quickly rearranging amplifiers and other equipment of a recording or broadcast studio.

POINT-CONTACT DIODE

See Diode (Point-Contact)

POTENTIOMETER

See Resistor (Potentiometer)

POTENTIOMETER (TRIMMER)

See Resistor (Trimmer Potentiometer)

POWER-SUPPLY FILTER (CHOKE)

See Choke (Power-Supply Filter)

POWER TRANSFORMER

See Transformer (Power)

PRINTED-CIRCUIT TERMINAL

See Terminal (Printed-Circuit)

PULSE TRANSFORMERS

See Transformer (Pulse)

R

RADIO-FREQUENCY CHOKE

See Choke (Radio-Frequency)

RADIO-FREQUENCY TRANSFORMER

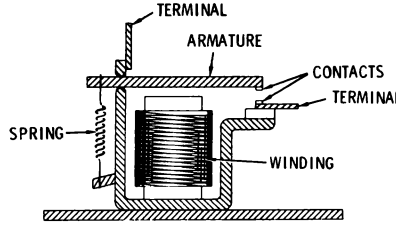
See Transformer (Radio-Frequency)

READOUT LAMP

See Lamp (Readout)

RELAY (BASIC)

A switch using an electromagnetic force to open or to close a circuit. In general, the relay has an electromagnet acting upon an armature (clapper). The armature, serving as one contact of the switch, is pulled toward or away from the second contact by an electromagnet. Electrical power applied to the electromagnet winding attracts the armature toward its core to make or break the switch contacts. Removal of electrical power from the electromagnet permits a spring to pull the armature away from the core to reverse the operation.



Basic relay.

RELAY (LATCHING)

The latching relay has a mechanical latch holding its armature in position after the magnetizing power is removed. After the low voltage has closed the contacts of the latching relay, it can be removed. That is, the latch will hold the contacts closed until released.

Release may be by mechanical or electrical means. The electrical release, or reset, uses a second coil and has the advantage of providing control at any distance from the relay. In the case of the transmitter, the downtown studio operator can open and close the latching relay at the transmitter several miles out in the country.

RELAY (OVERLOAD)

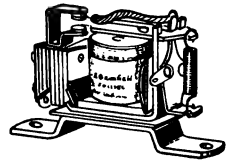
A relay acting much the same as a magnetic circuit-breaker. As a current exceeds a fixed value, an electromagnet pulls the armature away from the contact to prevent an overload. Such overload relays are often found in the modulator and output stages of a-m broadcast transmitters.

RELAY (PLATE-CIRCUIT)

A relay designed for use within the plate, or anode circuit of an electron tube. The plate-circuit relay has a coil resistance ranging from 2500 to 10,000 ohms to provide the load impedance. Often, the coil resistance will be made equal to the plate resistance of the electron tube and in this manner may serve as a part of the amplifying circuit. Plate-circuit relays are used in photocell circuits, counter circuits, and automatic door openers.

RELAY (POWER)

A relay built to handle considerable amounts of power. The power relay differs from other relays primarily in its larger contact size. However, with larger contacts the armature must be larger and in turn the operating coil must also be larger. Therefore, power relays with contact ratings up to 1000 amperes are in general much larger than other types.



Power relay.

RELAY (STEPPING)

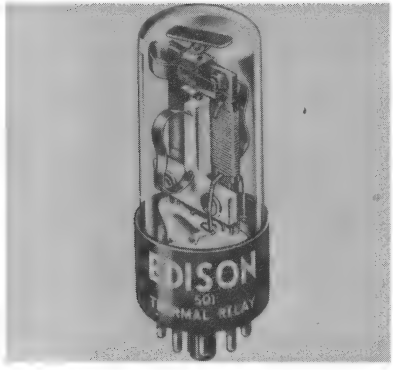
A relay arranged to serve as a rotary switch. The stepping relay has an armature mechanically linked with a ratchet that turns a disk holding one contact. As that one contact turns, it touches a number of other contacts in succession. The number of other contacts var-

Stepping relay.

ies from 10 to 50 or more. Because of the association with the ten digits (1, 2, 3, 4, 5, 6, 7, 8, 9, 0), the 10-contact, stepping relay is popular and is used with dial telephone switching circuits and calculating machines.

RELAY (THERMAL)

A relay that is sensitive to heat instead of the energizing and de-energizing of a coil.



Thermal relay.

RELAY (TIME-DELAY)

A switch that has its contacts opened or closed at a specified time after an actuating current is applied. The time-delay relay does not have an electromagnet but depends upon heat or other physical factors to open or close its contacts. For example, one type uses a heating element. The actuating current flows through a heating element, and a bimetallic strip bends to open or close the contacts. Since a larger current will heat the bimetallic strip faster, the time delay is dependent upon the actuating current. With standard voltage ratings of 6.3, 26, and 115 volts, the length of the time delay can range from 20 to 180 seconds.

RESISTOR (BALLAST)

A resistor used to develop excess voltage. One common use of a ballast resistor is seen when used with series operated electron tubes. The five or six tubes within a radio receiver may use 85 volts and a ballast resistor must be used to develop the additional 30 volts from the 115-volt line. Ballast resistors can be common carbon or wire-wound. There are also ballast line cords and ballast tubes (plug-in units containing a number of high wattage resistors). One type of ballast resistor presently being used has an iron-alloy wire element sealed in a hydrogen-gas-filled envelope that increases its resistance as its current increases.

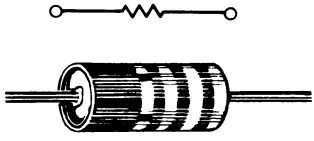
RESISTOR-CAPACITOR TESTER

An instrument used for determining the resistance of resistors and also the capacitance and power factor of capacitors. Built around an impedance bridge, the resistor-capacitor tester has a tuning-eye

electron tube as a null detector. Fundamentally, the bridge consists of four impedances arranged in a diamond configuration with 60 Hz power supplied by way of a step-down transformer across opposite points of the diamond. Across the other two points of the diamond, the tuning-eye electron tube is placed to indicate when the bridge is in balance (when the two points are nearly equal in potential). Such a balanced condition occurs when the variable, calibrated impedance (resistance) in one side of the bridge equals that unknown impedance (resistor or capacitor) in the opposite side of the bridge.

RESISTOR (CARBON-COMPOSITION)

A resistor using a length of carbon material as its resistive element. The carbon-composition resistor is commonly color coded with regard to resistance value and tolerance. Resistance values range from less than 1.0 ohm to over 20 megohms. Common tolerances for carbon-composition resistors are ± 5% and ± 10%, but there is a form of carbon resistor with a tolerance of better than 1%. These carbon-composition resistors are of the film variety and have a film of carbon sprayed or electroplated upon a ceramic tube. Carbon-composition resistors are also rated with regard to power dissipation which ranges from 1/4 to 2 watts.



Carbon resistor.

RESISTANCE DECADE BOX

See Decade Resistance Box

RESISTOR (POTENTIOMETER)

A variable resistance having a wirewound or carbon-composition element. Rotation of a centered shaft moves a contact arm across the resistance element to provide a continuous variation in resistance. With terminals at each end of the resistance element and a terminal for the moving contact, the potentiometer can be used in a variety of ways.

Variable resistor.

RESISTOR (TRIMMER POTENTIOMETER)

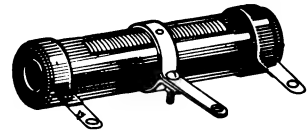
A variable resistance having a wirewound or carbon-composition

element. With a screwdriver slot adjustment, the trimmer potentiometer is intended for semipermanent adjustment. The common trimmer potentiometer has an elongated element with a sliding contact moved by the turning of a screw. Intended for printed-circuit mounting, the trimmer potentiometer has resistance ratings from 50 ohms to 1.0 megohm. Another form of trimmer potentiometer has a circular-shaped element with a sliding contact turned by a screwdriver. These resistance values range from 100 ohms to 3.5 megohms.

Trimmer potentiometer.

RESISTOR (WIREWOUND)

A resistor having a length of resistance wire as its resistive element. This resistance wire is wound upon a ceramic tube in a single layer and protected by an outer layer of ceramic or vitreous enamel. Wire leads or solder lugs are attached to each end of the resistor element and in some instances a fixed or movable terminal is placed between the ends. Wirewound resistors have resistance ratings ranging from 1.0 to 100,000 ohms with 5%, 10%, and 20% tolerances. Their power rating is from 5 to 1000 watts.



Wirewound resistor (adjustable).

RESONATING CAVITY

See Cavity (Resonating)

RIBBON MICROPHONE

See Microphone (Ribbon)

ROTARY SWITCH

See Switch (Rotary)

RUBY LASER

See Laser (Ruby)

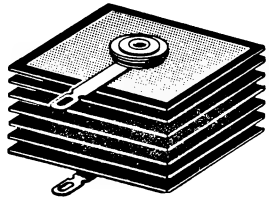
S

SATURABLE REACTOR

An electromagnetic component providing a variable inductance for the control of alternating current. The saturable reactor has one winding of a large number of turns and another winding of relatively few number of turns. Both windings are around an iron core. The larger or control winding carries a direct current whose value can be adjusted. Adjustment of this control-winding current alters the degree of magnetic saturation. As the control-winding current increases, the magnetic saturation of the iron core increases. In turn, as the control-winding current increases, the inductance of the second or load winding decreases. With a decrease in inductance, the load winding will pass more current.

SELENIUM RECTIFIER

A metallic rectifier used for power rectification. The selenium rectifier uses a film of selenium in contact with iron. In one direction this selenium-iron combination presents a high opposition to current, while offering low resistance to current in the opposite direction. Selenium rectifiers are rated from 50 mA to over 100 amperes at 15 to 10,000 volts. Battery chargers and various electronic power supplies use selenium rectifiers.



Selenium rectifier.

SELSYN

A motor and generator device serving as a position indicator. The selsyn is primarily a three-phase motor. When the shaft of one selsyn is rotated by an external means, a current is generated. Electrically connected to a second or receiver selsyn, this generated current causes the shaft of the receiver selsyn to rotate. Since the generated current is of the three-phase variety, the rotation of the receiver selsyn is precisely that of the generating or transmitting selsyn. If the transmitting selsyn is mechanically coupled with a wind-direction indicator, the receiver selsyn, with a pointer and scale, will indicate the wind direction at some remote point. Other applications include industrial controls and remote antenna positioning.

SHUNT (METER)

A form of resistance used to extend the range of a current-indicating meter. The meter shunt bypasses a portion of the total cur-

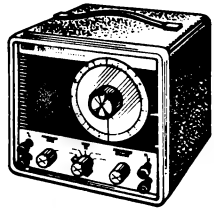
rent away from the meter. The total current is then proportional to the ratio of the meter and shunt resistances to the shunt resistance.

SHUNT (UNIVERSAL)

A meter shunt that may be used with a current meter of any resistance. The universal shunt consists of a known resistance having fixed and proportional taps. *Also see Shunt (Meter).*

SIGNAL GENERATOR (AF)

A generator of audio-frequency (af) signals. With a frequency range of approximately 20 Hz to 20 kHz, the af generator is a variable-frequency, audio oscillator. Selector switches provide for continuous coverage of this frequency

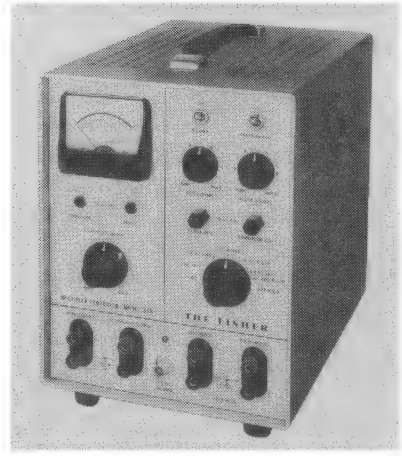


Af signal generator.

range in four or five bands. Some af generators generate both sine and square waves. Provision is provided for attenuation of the output. Audio frequency generators are valuable in testing receivers, transmitters, and hi-fi equipment.

SIGNAL GENERATOR (MULTIPLEX)

A generator of an fm multiplex signal. The multiplex signal generator develops the carrier frequency (88 to 108 MHz), the 19-kHz pilot-carrier, and the sum and difference signals necessary for the servicing of multiplex (stereo) fm receivers.



Multiplex signal generator.

SIGNAL TRACER

A test instrument used for tracing a rf or af signal through electronic equipment such as phonographs, radio receivers, and television receivers. Basically the signal tracer is a high-gain audio amplifier connected to a speaker and possibly to a visual indicator (a meter or tuning-eye tube). In rf or i-f sections, a rf probe is used to demodulate the rf wave. As this rf probe

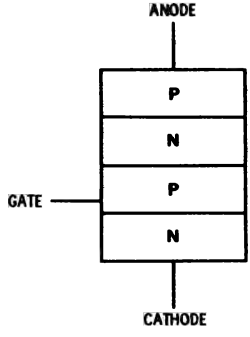
or the regular test probe is moved from point to point within a receiver, the presence or absence of a signal, as indicated by sound from the speaker or by visual indication, reveals defective portions of the circuit.

SILICON CONTROLLED RECTIFIER

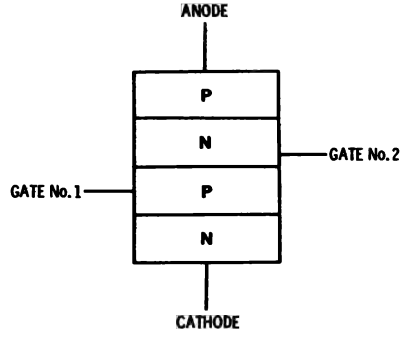
A solid-state device capable of abrupt switching from the nonconducting to the conducting state. The silicon controlled rectifier consists of four sections; two sections of p-type material and two of n-type material. Anode and cathode terminals are connected to the outer crystal sections while a gate terminal connects to the section next to the cathode. Initial external voltage between the cathode and anode puts the center junction into a reverse-biased condition and no current will flow. However, when a forward-biased voltage is applied across the cathode-gate junction the resulting current provides the current carriers necessary to break down the charge barrier of the reverse-biased junction. The anode to cathode current avalanches to its maximum and can only be stopped by reducing the anode to cathode voltage; removal of the gate-cathode voltage will not stop the anode to cathode current.

SILICON CONTROLLED SWITCH

A solid-state device capable of abrupt switching from the nonconducting to the conducting state. The silicon controlled switch is similar to the silicon controlled rectifier but has a second gate. In this manner, the silicon controlled switch can be triggered by either a positive or a negative pulse and requires less gate current for triggering. *Also see Silicon Controlled Rectifier.*



Silicon controlled rectifier.



Silicon controlled switch.

SILICON CONTROLLED SWITCH (LIGHT-ACTIVATED)

See Light-Activated Silicon Controlled Switch

SILICON DIODE

See Diode (Silicon)

SILICON DIODE PHOTOCELL

See Photocell (Silicon Diode)

SILICON TRANSISTOR

See Transistor (Silicon)

SLIDE SWITCH

See Switch (Slide)

SLOW-BLOW FUSE

See Fuse (Slow-Blow)

SLUG-TUNED COIL

See Inductor (Slug-Tuned)

SLUG-TUNED INDUCTOR

See Inductor (Slug-Tuned)

S-METER

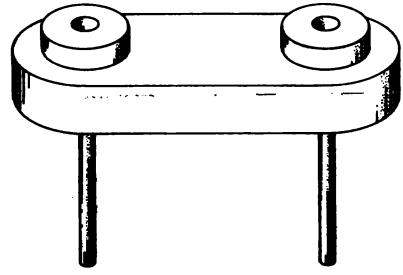
See Meter (S-meter)

SOCKET (CATHODE-RAY TUBE)

A means of providing electrical contact with the elements of a cathode-ray tube (crt). The crt socket consists of a phenolic base with a number of contact holes matching the contact pins on the neck end of the tube. At the center of the crt socket is a larger hole and keyed slot.

SOCKET (CRYSTAL)

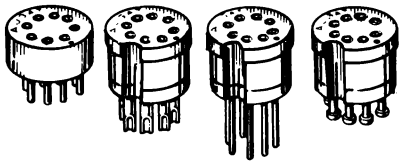
A means of providing electrical contact and mechanical mounting for quartz crystals. Made of ceramic material for lower radio-frequency losses, the crystal socket has spring contacts to hold the pins of the crystal firmly as well as giving good electrical contact.



Crystal socket.

SOCKET (INTEGRATED-CIRCUIT)

A means of providing electrical contact and mechanical mounting for integrated circuits. Available



Integrated circuit socket.

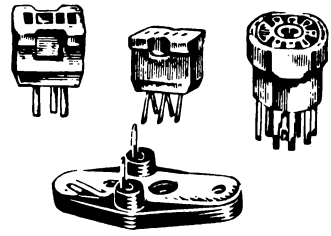
for use with conventional wiring or printed circuits, the integrated-circuit socket facilitates the insertion or removal of integrated circuits from their boards.

SOCKET (LAMP)

A means of providing electrical contact and mechanical mounting for lamps. In electronics most lamp sockets are of the miniature variety. However, many varieties exist: screw-in, bayonet, flanged, spring-contact, and wire lead. Lamp sockets are also classified with regard to mounting and purpose. It should also be noted that some neon and argon lamp sockets have built-in, current-limiting resistors.

SOCKET (TRANSISTOR)

A means of providing electrical contact, mechanical mounting, and easy removal from a circuit for a transistor. The transistor socket consists of a phenolic base with a number of holes matching the leads or contact pins of the transistor. Either screws or a retaining ring provide for mounting of the transistor socket.



Transistor socket.

SOCKET (TUBE)

A means of providing electrical contact, mechanical mounting, and easy removal from a circuit for an electron tube. The tube socket consists of a phenolic base with a number of holes matching the contact pins of the tube. Tube sockets have 4, 5, 6, 7, 8, 9, and 11 contacts which may be large or small. Screw or rivet holes and retainer rings provide the means for the mounting of tube sockets.

SOLAR BATTERY

See Photocell (Photovoltaic)

SOLDER TERMINAL

See Terminal (Solder)

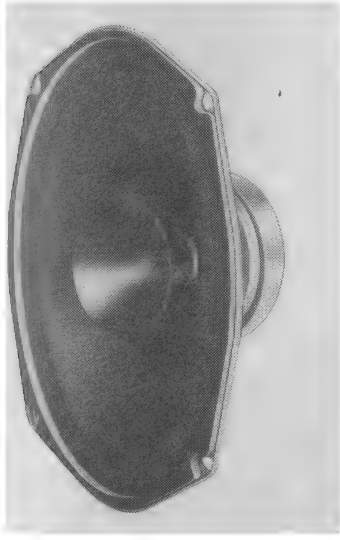
SPAGHETTI

A tubular form of insulation used to cover conductor wires or component leads. Spaghetti comes in a variety of materials including fiber-

glass, Teflon, plastic, and fabric. They come also in different inside diameters.

SPEAKER (COAXIAL)

A combination of a high-frequency speaker, known as the tweeter (mounted within the cone) and a low-frequency speaker, known as the woofer. The higher audio frequencies cannot be readily reproduced by the large cone of

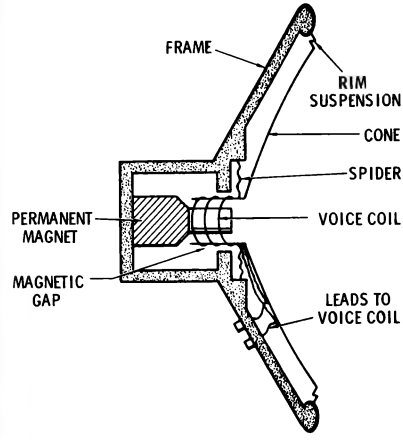


Coaxial speaker.

the woofer. However, by feeding the higher audio frequencies to the tweeter and the lower audio frequencies to the woofer, the entire audio-frequency range is covered efficiently.

SPEAKER (DYNAMIC)

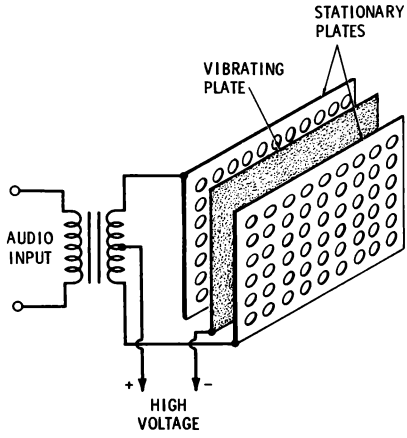
A transducer converting electrical variations into sound waves. The dynamic speaker has a small voice coil within the magnetic field of a permanent magnet or of an electromagnet. When an audio-frequency current passes through the voice coil, the developed magnetic field reacts with the fixed magnetic field to cause the voice coil and attached cone to vibrate and produce sound waves. Cones for dynamic speakers range from 2 inches to 15 inches while the voice coils have impedances of from 4 to 16 ohms.



Dynamic speaker.

SPEAKER (ELECTROSTATIC)

A transducer converting electrical variations into sound waves using electrostatic attraction and repulsion. The electrostatic speaker

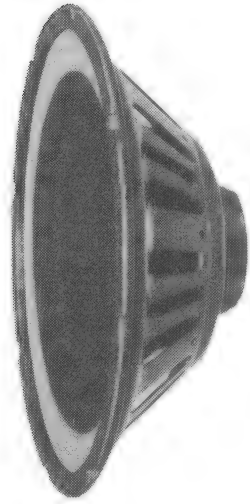


Electrostatic speaker.

has two sheets of metal foil separated by a plastic film and fastened to an insulating frame. With a dc voltage applied to one foil and an audio-frequency voltage applied to the second foil, the potential between the two foils alternately becomes the same and then the opposite polarity. Opposite polarity potentials attract the foils together while like polarity potentials repel the foils apart. Thus, the foils vibrate to produce sound waves. Since there is no actual passage of current through an electrostatic speaker, its impedance is very high. Electrostatic speakers reproduce the higher audio frequencies much better than the lower audio frequencies.

SPEAKER (MIDRANGE)

A speaker reproducing the frequencies near the middle of the audio-frequency range. The cone size of a midrange speaker is somewhere between the tweeter cone size and the woofer cone size. Often the woofers reproduce the lower audio frequencies and the tweeters

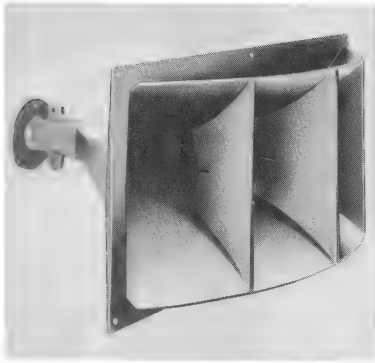


Midrange speaker.

reproduce the higher audio frequencies, but those frequencies between 500 Hz and 5000 Hz are often not properly reproduced by either the tweeter or the woofer. Therefore, it is desirable to have a midrange speaker.

SPEAKER (SECTORAL HORN)

A speaker normally used for high frequency reproduction. It has two parallel and two diverging sides.



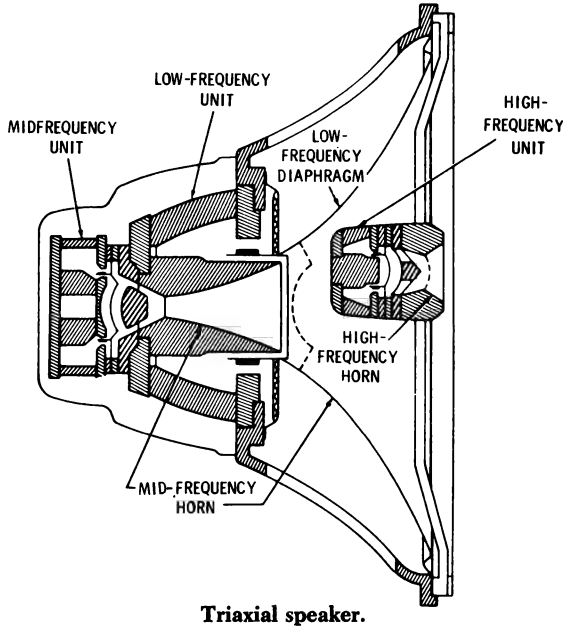
Sectoral horn.

SPEAKER (TRIAXIAL)

An acoustical integrated speaker with three independently driven units (high, middle, and low frequency). Being previously adjusted by the manufacturer, such problems as matching the efficiency of separate speakers, minimizing phase differences, quality of tonal response, polar pattern and impedance matching have already been solved.

SPEAKER (TWEETER)

A speaker used for the reproduction of the higher audio frequencies —2000 to 20 kHz. Rather than having a cone, the tweeter commonly has a lightweight diaphragm made of metal or plastic. Since the tweeter does not handle as much power as a woofer, the tweeter has a less powerful magnet.



Triaxial speaker.

SPEAKER (WOOFER)

A speaker for the reproduction of the lower audio frequencies—40 to 500 Hz. The actual frequency range is dependent upon the cone diameter of the woofer—a large diameter cone reproduces lower frequencies. A woofer must also have a very strong magnetic field to handle the larger amounts of power within the lower audio-frequency waves and to dampen undesired variations. Cone diameters of woofer speakers range from 8 to 18 inches and some special purpose woofers have been built with cone diameters as large as 30 inches.

STEPPING RELAY

See Relay (Stepping)

STEREO PHONO CARTRIDGE

See Phono Cartridge (Stereo)

STRAIN GAUGE

An electromechanical transducer used in determining mechanical stress or strain acting upon an object.

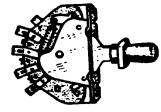
STRIPS (TIE-POINT)

See Tie-Point Strips

SWITCH (LEVER)

A switch operated by the movement of a lever. One basic type of lever switch consists of a number of long, narrow metal strips separated by insulation at one end. At the opposite end of these metal strips, the lever movement causes various contacts to join or to part. The lever normally has three positions; two active (on) positions with a neutral (off) center position. Because of their ability to handle a number of switching functions, being rugged and having the convenience of the long handle, lever switches are often used in telephone switchboards and sound-studio equipment.

Another form of the lever switch is similar to a rotary switch with the lever simply rotating one (or more) movable contacts across a number of fixed contacts.

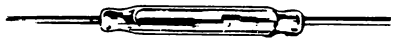


Lever switch.

SWITCH (MAGNETIC-REED)

A switch operated by magnetic action. The magnetic-reed switch consists of two metal reeds and contact points sealed within a glass tube. Electromagnet (solenoid) or a permanent magnet will serve to draw the two contacts of a mag-

netic-reed switch together. By being sealed in glass, any sparks developed by opening and closing the contacts of a magnetic-reed switch

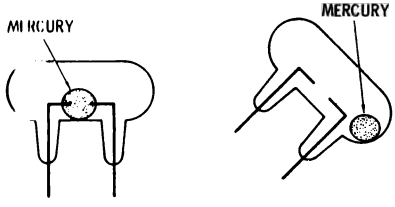


Magnetic reed switch.

will not cause an explosion where gases are present. The glass enclosure also protects the electrical contacts from corrosion and oxidation.

SWITCH (MERCURY)

A switch using a small pool of mercury for its contact action. The mercury switch commonly has two metal electrodes and a small quantity of mercury within a glass en-



Mercury switch.

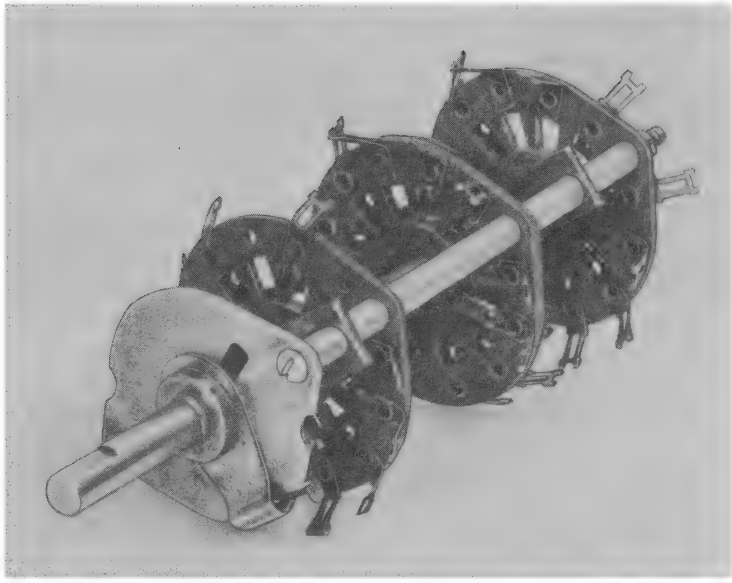
closure. The mercury is a semi-liquid globular mass that rolls about as the unit is tilted from side to side. In one position, the mercury will touch both metal electrodes to complete the electrical circuit. Mercury switches may be used with intrusion alarms and counters and as safety tilt switches and level controls.

SWITCH (ROTARY)

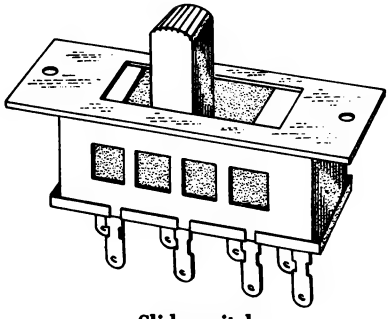
A switch with a number of stationary contacts and a rotating contact arm. The stationary contacts and related solder terminals are mounted upon a ceramic or phenolic disk-shaped base. At the center of this disk the rotating contact arm is fastened to a shaft. As this shaft is turned, the contact arm makes contact with one or more of the stationary contacts. When desired, more than one stationary contact disk and an equal number of rotating contact arms may be arranged on a single shaft.

SWITCH (SLIDE)

A switch being opened and closed by a sliding mechanism. The slide switch has a small button that moves or slides within a slot. Attached to this sliding button is a metal bar. When the button is moved to one end of the slot, the metal bar touches only one of the enclosed contacts. Moved to the opposite end of the slot, the metal bar touches both contacts and the circuit is closed. With maximum current rating of about 10 amperes, the slide switch is used primarily as the on-off switch of small electrical appliances.



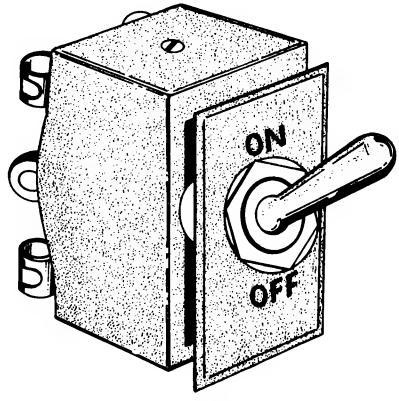
Rotary switch.



Slide switch.

SWITCH (TOGGLE)

A switch opened and closed by a lever action. The toggle switch has a cam-like lever pushing a spring contact toward a fixed contact. In most cases the cam is shaped to lock into either the on or the off position. However, the cam may also be shaped to permit a momentary action, lasting



Toggle switch.

only as long as the lever is held. With current ratings up to 20 amperes, the toggle switch is most frequently used in power circuits.

SWITCH (T-R)

A switching device to alternately connect a single antenna to the output of a transmitter or to the input of a receiver. Police and fire communications systems commonly use a single antenna for both receiving and transmitting and a T-R switch to make the necessary switching. One variety of T-R switch uses a relay. Current through the relay solenoid pulls the armature down and connects the antenna to the transmitter. With no current through the solenoid, the armature is in its up position to connect the antenna to the receiver. Another form of T-R switch uses electronic switching.

SYNTHETIC FILM CAPACITOR

See Capacitor (Synthetic Film)

T

TERMINAL (CRIMP-ON)

A terminal for component leads or for connecting wires. The wire or the component lead is pushed through the crimp-on terminal and the application of pressure crimps the wire or the lead into place. Thus, a good electrical connection has been made without soldering. Crimping these wires into the crimp-on terminal usually requires a special tool.

TERMINAL (PRINTED-CIRCUIT)

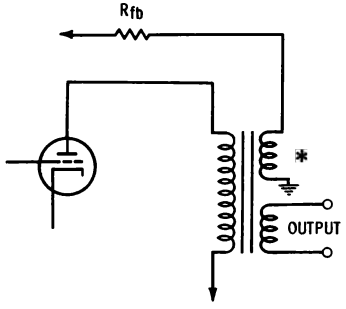
A variety of terminals specifically designed for printed-circuit boards and their assemblies. Some printed-circuit terminals are of the multiple-contact type for plugging the board into another circuit or other partions of the circuit. Other printed-circuit terminals are single-contact types and lead-insertion metal eyelets.

TERMINAL (SOLDER)

A small terminal to which wires, cable conductors, and component leads are soldered. The common solder terminal (solder lug) is a small piece of tinned metal with a large hole and a smaller hole. The larger hole fits under the head of a mounting or chassis screw while the smaller hole permits insertion and soldering of the wire or lead.

COIL (TERTIARY)

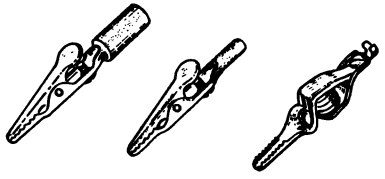
Normally used to supply a feedback voltage, the tertiary coil is simply a third coil of a transformer in addition to primary and secondary coils.



Tertiary coil.

TEST CLIPS

Metal clips attached to the ends of flexible and insulated wires providing for quick connection and disconnection from a circuit. Test



Test clips.

clips are constructed of two metal pieces hinged together with a spring action. Various shapes of test clips provide such names as alligator, claw (or battery), and insulation-piercing.

TEST LEAD

A flexible, insulated wire having an appropriate clip or probe at each end; used during the testing and servicing of an electronic circuit.

TEST SOCKET

A device providing measurements of electron-tube element voltages and currents. Placed between the regular tube socket and the tube, the test socket (or socket-test adapter) permits voltage and resistance measurements to be made without disturbing the remainder of the circuit. Test sockets are available for all types of tubes and tube sockets.

TETRODE ELECTRON TUBE

See Electron Tube (Tetrode)

TETRODE VACUUM TUBE

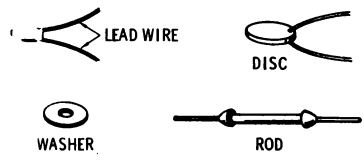
See Electron Tube (Tetrode)

THERMAL CIRCUIT-BREAKER

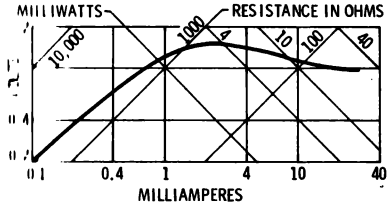
See Circuit-Breaker (Thermal)

THERMISTOR

A solid-state semiconductor whose resistance will vary with the



Typical thermistors.



Typical E-I curve.

Thermistor.

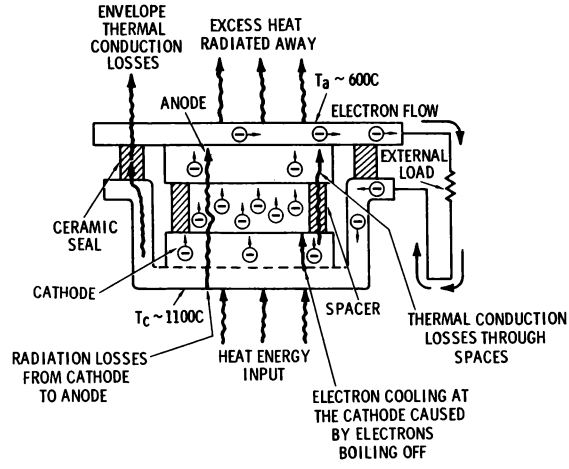
temperature. That is, a component whose resistance varies by a known, reproduceable amount. It is a two-terminal device made out of special mixtures or compounds which can be directly or indirectly heated. Its temperature coefficient of resistance is high, nonlinear, and negative.

THERMIONIC CONVERTER

A device that uses heat to produce electrical power. The device has two electrodes, both of which are enclosed in a vacuum or gas-filled envelope. The heated cathode emits electrons while the cold cathode collects them.

THERMOCOUPLE

A transducer converting heat energy into electrical energy. The thermocouple is constructed of two pieces of dissimilar metal bonded at one end. Heat applied to this metal bond will produce a voltage at opposite ends of the metal pieces.



Thermionic converter.

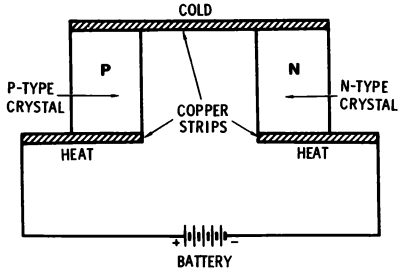
The voltage (millivolts) depends upon the amount of heat and upon the metals used in the thermocouple construction. When used with amplifiers and the correct meters, thermocouples may be used for temperature measurements, temperature control systems, protective devices, and the measurement of rf current.

THERMOCOUPLE METER

See Meter (Thermocouple)

THERMOELECTRIC ELEMENT

A solid-state transducer converting heat energy (hot or cold) into electrical energy, or conversely, converting electrical energy into heat energy (hot or cold). The thermoelectric element has a block of p-type crystalline material and a block of n-type crystalline material joined by a strip of copper. In this manner the copper strip becomes a part of the pn junction, and when passing current this pn junction absorbs heat. That is, the pn junction, including the copper strip, takes heat from the air to become cold. Opposite ends of the p and n crystal blocks produce heat and become hot. Conversely, if cold is applied to the pn junction by way of the copper strip, a voltage is developed between opposite ends of the p and n crystal blocks.



Thermoelectric element.

THYRATRON

See Electron Tube (Thyratron)

TIE-POINT STRIPS

A piece of hardware providing connecting and terminating points for the different components within an electronic circuit. Tie-point strips consist of one or more solder terminals mounted on a strip of insulating material. Provided with mounting feet, the tie-point strip may be secured to the chassis.

TIME-DELAY RELAY

See Relay (Time-Delay)

TIMER (INTERVAL)

See Interval Timer

TOGGLE SWITCH

See Switch (Toggle)

TOROIDAL CORE

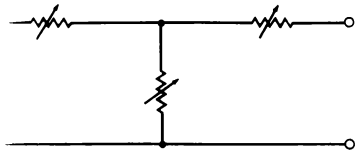
A doughnut-shaped core of magnetic material. Toroidal cores are usually made of ferrite (powdered-iron) mixed with an insulating cement and compressed into form. Uses for toroidal cores include pulse transformers, transistor power inverter transformers, and computer magnetic memories.

TOROIDAL TRANSFORMER

See Transformer (Toroidal)

T-PAD

A combination of three resistors (sometimes variable) arranged in a T-shaped configuration. Used to control the amount of power delivered to a load, the T-pad provides a constant load impedance to the amplifier.



T-pad.

TRANSDUCER (HEADPHONE)

See Headphone (Crystal), Headphone (Dynamic), and Headphone (Magnetic)

TRANSDUCER (MICROPHONE)

See Microphone (Carbon), Microphone (Ceramic), Microphone (Condenser), Microphone (Crystal), Microphone (Dynamic), Microphone (Ribbon), Microphone (Wireless)

TRANSDUCER (TELEMETRY)

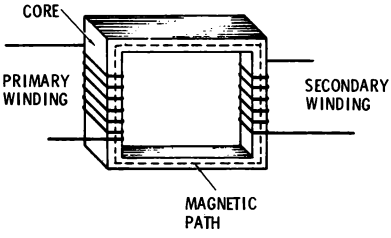
A device used in the transmission of telemetry. In general, telemetry is the determination of some physical quantity or occurrence from a remote point. For example: the heart beats of our astronauts walking on the moon are carefully monitored at stations here on earth. Oddly enough the human body functions as its own transducer and converts its movements—such as, the heart beats—into electrical impulses. If we wish to measure acceleration (the change in the velocity of a body) from a remote point, an *accelerometer* consisting of ceramic discs mounted between a mass and a base is used. When the base is attached to an accelerating body the ceramic discs are placed under more or less pressure to produce a voltage.

TRANSDUCER (ULTRASONIC)

See Ultrasonic Transducer

TRANSFORMER

An electromagnetic device having two or more windings on the same magnetic core. With changing current, the primary winding



Transformer.

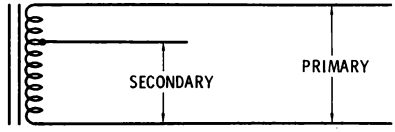
develops a changing, magnetic field which produces voltages across the secondary windings.

TRANSFORMER (AUDIO-FREQUENCY)

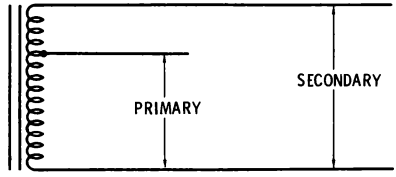
A transformer used with audio frequencies from approximately 20 Hz to 20 kHz. Audio-frequency transformers are of many varieties including audio input, audio-interstage coupling, modulation, and audio output. Special core materials and coil-winding configurations are used in audio-frequency transformers to acquire the necessary frequency response and low distortion. Audio-frequency transformers used with low signal levels are generally shielded against interference created by stronger magnetic fields. Audio-frequency transformers are used in coupling the output of an audio amplifier to a speaker, in applying audio-frequency modulating signals to a rf carrier signal, and in coupling a microphone to the input of an amplifier.

TRANSFORMER (AUTOTRANSFORMER)

A transformer having a single winding used as both the primary and secondary. The primary may encompass the entire winding while the secondary then utilizes only a



Step down.



Step up.

Autotransformer.

portion of the winding, thus forming a step-down transformer. However, it is also possible to use only a portion of the winding as the primary and the entire winding as the secondary (step-up transformer). Thus, the autotransformer can be used as a voltage step-up or a voltage step-down device. Flyback transformers in television receivers are often of the autotransformer

variety as are the ignition coils in automobiles.

TRANSFORMER (CONSTANT-VOLTAGE)

A transformer tending to maintain its secondary voltage at a constant value regardless of primary voltage fluctuations. The principle of core saturation is utilized in the most common type of constant-voltage transformer. Power ratings for constant-voltage transformers range from 10 watts to several kilowatts.

TRANSFORMER (FILAMENT)

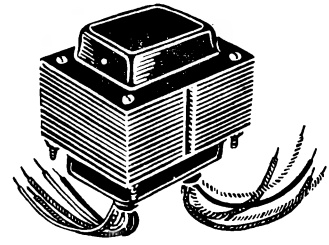
A transformer providing the operating voltage for electron-tube heater filaments. The filament transformer has a 115-volt primary winding and one or more low-voltage secondary windings over a laminated-steel core. These secondary windings have voltages ranging from 2.5 to 25.6 volts.

TRANSFORMER (FLYBACK)

A transformer used in television receivers coupling the horizontal output to the deflection yoke and providing high voltage for the picture tube. As the magnetic field of the deflection yoke collapses during the retrace (flyback time), a voltage pulse is transformed to a higher voltage for the picture tube.

TRANSFORMER (POWER)

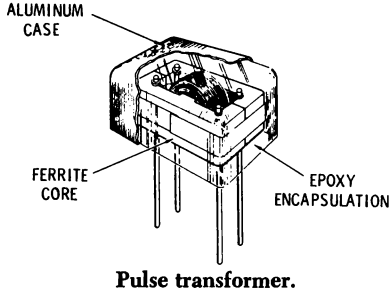
A transformer designed to provide operating power for electronic equipment. A power transformer contains a single primary winding and one or more secondary windings. Power transformers intended for use with vacuum-tube circuits generally contain two or more secondary windings. However, power transformers designed for transistor circuits normally have only a single secondary winding since transistors do not require heater voltages.



Power transformer.

TRANSFORMER (PULSE)

A transformer used for the handling of electrical pulses. The core of

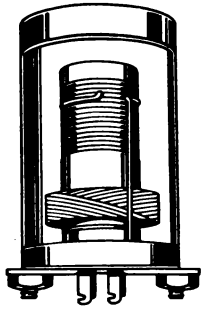


Pulse transformer.

a pulse transformer is often of the toroidal type. (*Also see Toroidal Core.*) Many pulse transformers employ special winding and insulating techniques because of the high voltages encountered.

TRANSFORMER (RADIO-FREQUENCY)

A transformer used in radio-frequency circuits. The coupling of radio-frequency amplifier stages, such as the intermediate-frequency stages of a superhetrodyne receiver, is the most common use of radio-frequency transformers. The



Rf transformer.

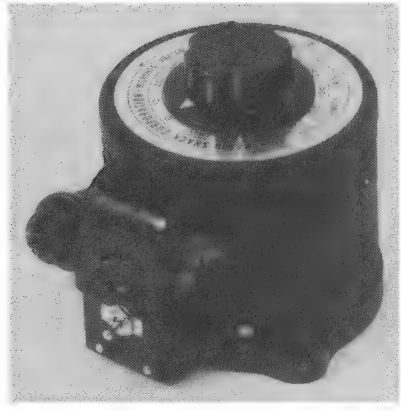
radio-frequency transformer usually has single primary and secondary windings; employing either an air core or a ferrite core to decrease core loss. Radio-frequency transformers are also used with radio-frequency filters, antenna-matching circuits, and high-voltage radio-frequency power supplies.

TRANSFORMER (TOROIDAL)

Any transformer using a toroidal core for higher magnetic efficiency. By minimizing radiation from the core and the windings, the toroidal core makes it possible to obtain inductances of precise and stable values. Toroidal transformers are used as variable voltage transformers, pulse transformers, and in oscillators.

TRANSFORMER (VARIABLE-VOLTAGE)

A transformer providing a variable output voltage. The variable-voltage transformer has a toroidal core and a single-layer winding of insulated copper wire. Functioning as an autotransformer, the single-layer winding serves as both primary and secondary. This is a step-up voltage arrangement with the



Variable-voltage transformer.

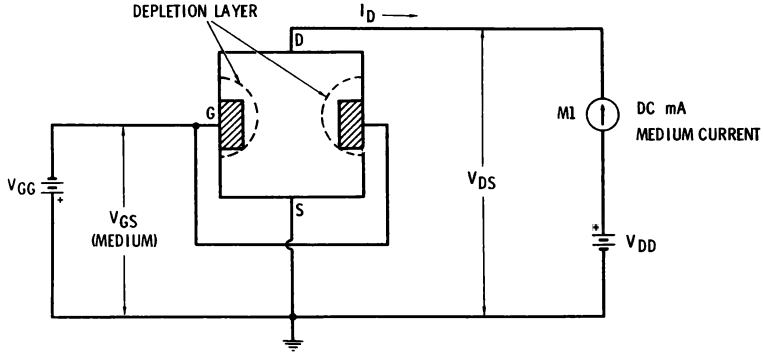
primary voltage of 115 volts across only a portion of the complete winding. At the center of the toroidal core and winding, a rotating shaft, contact arm, and brush provide a movable contact. As the movable contact is rotated, the voltage is varied from 0 to 140 volts.

TRANSISTOR (EPITAXIAL)

A solid-state device capable of providing amplification of an electrical signal. In operation the epitaxial transistor uses electrons and holes (bipolar) for current carriers. In general, the epitaxial transistor is grown upon a wafer of heavily doped crystalline material. This heavily doped wafer serves as the collector section. By photolithographic and masking techniques, the base and emitter regions are added in an atom by atom growth process. Such construction provides a larger collector volume that can handle greater amounts of power and lower junction capacitance to improve high-frequency operation. Basic bipolar transistor theory is further discussed under *Transistor (Junction)*.

TRANSISTOR (FIELD-EFFECT)

A solid-state device capable of providing amplification of an electrical signal. The field-effect transistor (FET) is a unipolar transistor. That is, it uses only one type of current carrier, either electrons or holes,for amplification. A basic FET consists of a bar of p- or n-type crystal (usually silicon) having a contact at each end. One end contact is referred to as the *source* while the other end contact is referred to as the *drain*. On each side of the silicon bar is a *gate*. A voltage applied between the source and the drain develops a current



FET circuit.

through the center (*channel*) of the bar. In an n-channel the application of a negative voltage to the gate terminals repels the electrons away from the region to form a depletion area. In effect, the depletion area reduces the effective cross-sectional area of the channel and increases its resistance. Thus, as the negative gate voltage increases, the source-to-drain current decreases. However, this basic form of FET has a high gate impedance for negative voltages but an extremely low gate impedance for positive voltages. The MOS (metal-oxide semiconductor) type of field-effect transistor (MOSFET) has an insulation of silicon oxide between the gate contact and the channel. In this manner the MOSFET has a high gate impedance regardless of the applied voltage polarity. MOSFET's are further typed as being the *depletion* type or the *enhancement* type. The depletion type of MOSFET conducts current regardless of gate voltage polarity, while the enhancement type must have a forward-biased gate potential before source-drain current flows.

TRANSISTOR (GERMANIUM)

A transistor using p- and n-type germanium crystal material in its construction. For transistor operation, *Also see Transistor (Junction), Transistor (Epitaxial), Transistor (Mesa), Transistor (Field-Effect), and Transistor (Unijunction).*

TRANSISTOR (JUNCTION)

A solid-state device capable of amplifying an electrical signal. The junction transistor uses both types of current carriers, electrons and holes (bipolar). A junction transistor has three alternate layers of n- and p-type crystalline material. That is, the complete unit may have a npn or a pnp construction. One of the outer sections is the *emitter* and the other is the *collector*. Between the emitter and the collector sections is a thin crystal section referred to as the *base*. In normal operation the collector-base junction is reverse-biased so that little or no current flows in the external circuit. But when a forward-biasing voltage is placed upon the emitter-base junction, the resulting current also breaks down the charge-barrier of the base-collector junction to permit a flow of current in the emitter-collector circuit. As the emitter-base current increases, the emitter-collector current also increases. Thus, a small emitter-base current controls the much larger emitter-collector current. In this manner the junction transistor is capable of current amplification.

TRANSISTOR (MESA)

A solid-state device capable of providing amplification of an electrical signal. The mesa transistor is just one of a family of diffused-junction transistors. The name,

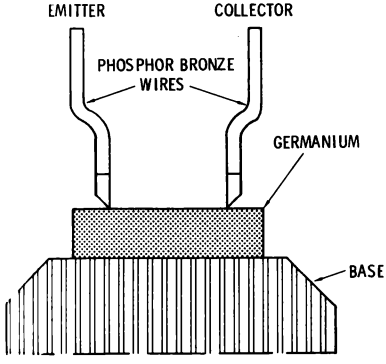
mesa transistor, comes from the mesa or flat-topped peak that is etched into the transistor as a means of reducing the base-to-collector junction area. Such construction gives lower capacity values between the transistor sections to improve high-frequency operation. The mesa transistor is also a bipolar transistor (uses electrons and holes as current carriers) operating in the same manner as the junction transistor.

TRANSISTOR (PHOTOCELL)

See Photocell (Transistor)

TRANSISTOR (POINT-CONTACT)

An early type of transistor having two point contacts mounted close together upon a block of doped crystal. The crystal block and its electrical contact acts as the emitter while one of the point contacts functions as the collector and the other as the base. The emitter-collector combination is reverse-biased and passes no current until the emitter-base combination is forward biased. With the base and collector contacts being closely mounted the emitter-to-base current-carrier movement breaks down the charge barrier in the emitter-to-collector path. The point-contact transistor has the disadvantage of not being able to handle large currents.



Point-contact transistor.

TRANSISTOR (SILICON)

A transistor using n- and p-type silicon crystal materials in its construction.

TRANSISTOR (SOCKET)

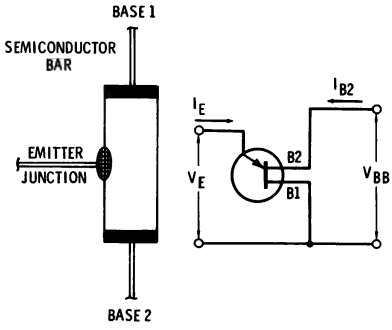
See Socket (Transistor)

TRANSISTOR (UNIJUNCTION)

A solid-state device used primarily for relaxation oscillators, silicon controlled rectifier trigger-circuits, sweep circuits of oscilloscopes and various timing circuits.

TRAVELING-WAVE TUBE

See Electron Tube (Traveling-Wave)



Unijunction transistor.

TRIAC

A form of silicon controlled rectifier (SCR) or thyristor having six crystal sections. In effect, the triac amounts to two SCRs operating in parallel. One is an npnp combination while the other SCR is a pnpn combination. A negative gate voltage applied to the inner n-type section of the npnp combination will trigger that SCR. The same gate terminal also makes contact with the p-type gate section of the second SCR which is triggered by the application of a positive gate voltage. The current direction through the first SCR, the npnp combination, is opposite of that through the pnpn combination.

TRIMMER CAPACITOR

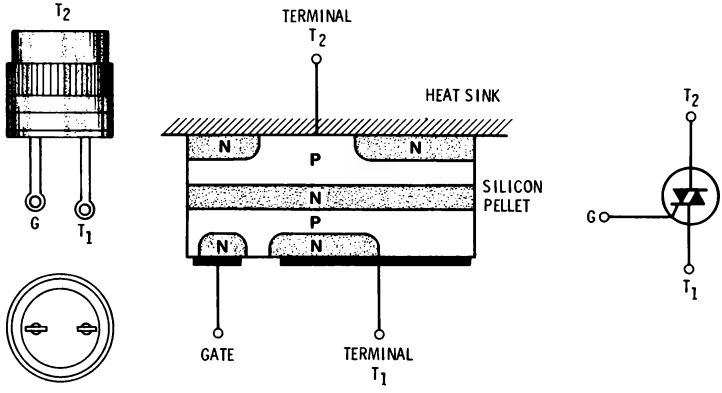
See Capacitor (Trimmer)

TRIMMER POTENTIOMETER

See Potentiometer (Trimmer)

TRIODE ELECTRON TUBE

See Electron Tube (Triode)



Package. *Pellet.* *Symbol.*

Triac.

TRIODE VACUUM TUBE

See Electron Tube (Triode)

T-R SWITCH

See Switch (T-R)

TUBE SHIELD

A metal cylinder placed over the envelope of an electron tube to eliminate the undesirable effects of electromagnetic and electrostatic fields.

TUBE SOCKET

See Socket (Tube)

TUBING (SHRINKABLE)

An insulating tubing with a diameter that shrinks when heated. It is slipped over wires, connectors, tool handles, etc., and then applied heat forms the shrinkable tubing into a tight-fitting insulating jacket. Typically 1/2-inch shrinkable tubing can shrink to 1/4-inch diameter with the heat from a soldering iron or gun.

TUNING-EYE ELECTRON TUBE

See Electron Tube (Tuning-Eye)

TUNNEL DIODE

See Diode (Tunnel)

TWEETER (SPEAKER)

See Speaker (Tweeter)

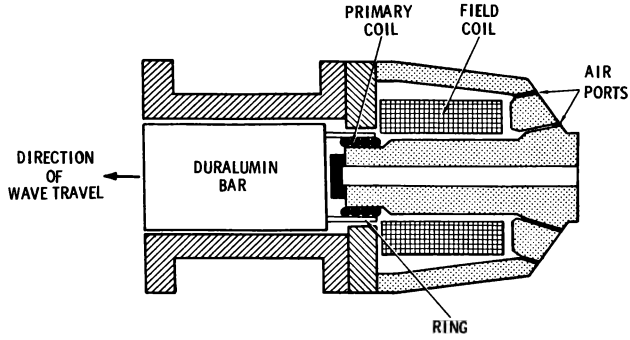
U

U-BOLT

A steel rod threaded at each end and bent into a "U" shape. U-bolts are commonly used for mounting antennas and antenna masts.

ULTRASONIC TRANSDUCER

An electromechanical device converting ultrasonic oscillations into mechanical vibrations. Ultrasonic oscillations are just above the audible range. In cleaning tanks



Ultrasonic transducer.

the ultrasonic transducer agitates the fluid to develop an efficient scrubbing action.

ULTRAVIOLET LAMP

See Lamp (Ultraviolet)

UNIJUNCTION TRANSISTOR

See Transistor (Unijunction)

UNIVERSAL SHUNT

See Shunt (Universal)

V

VACUUM TUBE

See Electron Tube (Beam-Power), Electron Tube (Diode), Electron Tube (Gaseous Voltage-Regulator), Electron Tube (Image Orthicon), Electron Tube (Klystron), Electron Tube (Magnetron), Electron Tube (Mercury-Vapor Diode), Electron Tube (Multisection), Electron Tube (Nuvistor), Electron Tube (Pentagrid Converter), Electron Tube (Pentode), Electron Tube (Tetrode), Electron Tube (Thyratron), Electron Tube (Triode), Electron Tube (Traveling-Wave), Electron Tube (Tuning-Eye), Electron Tube (Xenon), and Electron Tube (X-Ray).

VOLTAGE-REGULATOR (GASEOUS)

See Electron Tube (Gaseous Voltage-Regulator).

VOLTMETER

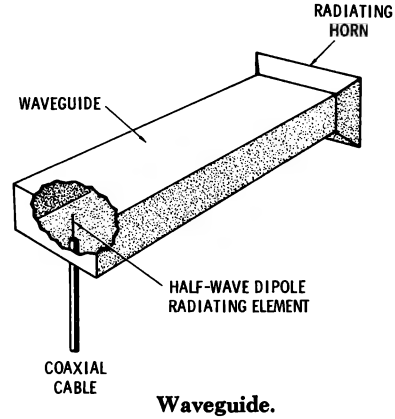
See Meter (Voltmeter), and Meter (Vacuum-Tube Voltmeter).

W

WAVEGUIDE

A form of transmission line used for microwave energy. As the frequency of an electromagnetic wave increases, its wavelength decreases. At frequencies above 500 MHz the half-wave antenna is less than 30 centimeters or 12 inches long.

The waveguide is a rectangular or round pipe filled with a dielectric. In most cases the dielectric is air, but other materials have been used. A primary use of waveguides is in the transmission of uhf power from the transmitter to the antenna. In many instances the waveguide terminates within a parabolic reflector and the wave reflects away from that reflector toward a distant receiving point.



Waveguide.

WHEATSTONE BRIDGE

A resistance circuit in the shape of a bridge network used for the measurement of resistance.

WIRE (MAGNET)

See Magnet Wire

WIRELESS INTERCOM

See Intercom (Wireless)

WIRELESS MICROPHONE

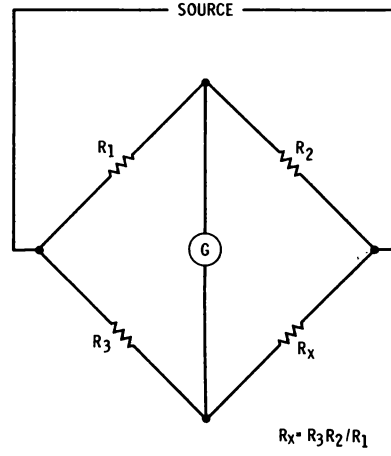
See Microphone (Wireless)

WIREWOUND RESISTOR

See Resistor (Wirewound)

WOOFER SPEAKER

See Speaker (Woofer)



Wheatstone bridge.

X

XENON TUBE

See Electron Tube (Xenon)

X-RAY TUBE

See Electron Tube (X-Ray)

Y

YAGI ANTENNA

See Antenna (Yagi)

YOKE (DEFLECTION)

See Deflection Yoke

Z

ZENER DIODE

See Diode (Zener)

ZINC-CARBON BATTERY

See Battery (Zinc-Carbon)

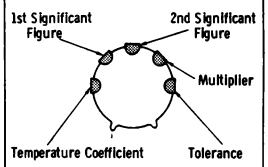
RESISTOR COLOR CODES

RESISTOR COLOR CODE

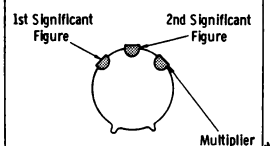
COLOR	SIGNIFICANT FIGURES	MULTIPLIER	TOLERANCE	FAILURE RATE*
Black	0	1	-	-
Brown	1	10	±1%	1.0
Red	2	100	±2%	0.1
Orange	3	1000	±3%	0.01
Yellow	4	10,000	±4%	0.001
Green	5	100,000	-	-
Blue	6	1,000,000	-	-
Violet	7	10,000,000	-	-
Gray	8	100,000,000	-	-
White	9	-	-	Solderable*
Gold	-	0.1	±5%	-
Silver	-	0.01	±10%	-
No Color	-	-	±20%	-

*When used on composition resistors, indicates percent failure per 1000 hours. On film resistors, a white fifth band indicates solderable terminal.

DISC CERAMICS (5-DOT SYSTEM)



DISC CERAMICS (3-DOT SYSTEM)



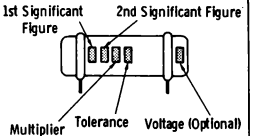
CERAMIC CAPACITOR CODES (CAPACITANCE GIVEN IN PF)

In reference to RS-198-A of the EIA, ceramic dielectric capacitors have three major classifications:
Class 1, temperature compensating ceramics requiring high Q and capacitance stability.
Class 2, where Q and stability of capacitance are not required.
Class 3, low voltage ceramics, where dielectric losses, high insulation resistance, and capacitance stability are not of major importance.

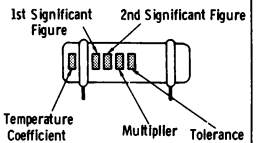
COLOR	DIGIT	MULTIPLIER	CLASS 1 TOLERANCE* 10 PF OR LESS	CLASS 1 TOLERANCE* OVER 10 PF	CLASS 1 TEMPERATURE COEFFICIENT PPM °C	CLASS 1 TEMP. COEFF. SIGNIFICANT FIGURE	CLASS 1 TEMP. COEFF. MULTIPLIER	CLASS 2 TOLERANCE*
BLACK	0	1	± 2.0 pF	± 20%	0	0.0	-1	±20%
BROWN	1	10	± 0.1 pF	±1%	-33		-10	
RED	2	100		±2%	-75	1.0	-100	
ORANGE	3	1000		± 3%	-150	1.5	-1000	
YELLOW	4	10,000			-220	2.2	-10,000	+100%,-0%
GREEN	5		± 0.5 pF	± 5%	-330	3.3	+1	±5%
BLUE	6				-470	4.7	+10	
VIOLET	7				-750	7.5	+100	
GRAY	8	.01	± 0.25 pF		+150 To -1500		+1000	+80%, -20%
WHITE	9	.1	± 1.0 pF	± 10%	+100 To -750		+10,000	±10%
SILVER								
GOLD								

*Tolerance on Class 3 Ceramic Capacitors is indicated by its code, either ± 20% (Code M) or +80, -20% (Code Z).

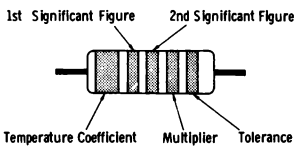
HIGH-CAPACITANCE TUBULAR CERAMICS INSULATED OR NONINSULATED



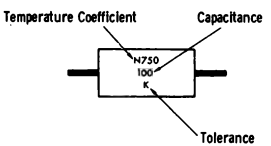
TEMPERATURE COMPENSATING TUBULAR CERAMICS



MOLDED-INSULATED AXIAL LEAD CERAMICS

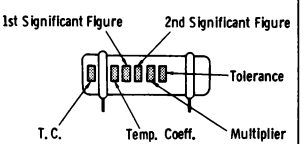


TYPOGRAPHICALLY MARKED CERAMICS

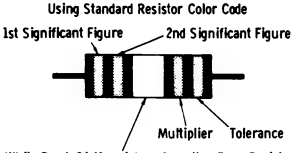


LETTER	TOLERANCE 10PF OR LESS	TOLERANCE OVER 10PF
B	± 0.1 pF	
C	± 0.25 pF	
D	± 0.5 pF	
F	± 1.0 pF	± 1%
G	± 2.0 pF	± 2%
J		± 5%
K		±10%
M		±20%

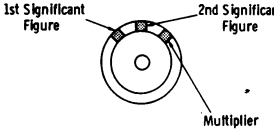
EXTENDED RANGE T.C. TUBULAR CERAMICS



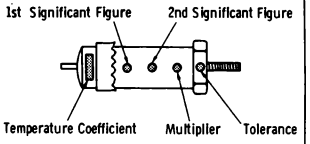
MOLDED CERAMICS
Using Standard Resistor Color Code



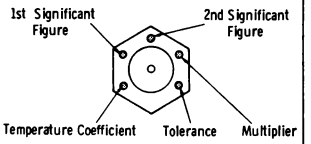
BUTTON CERAMICS



STANDOFF CERAMICS



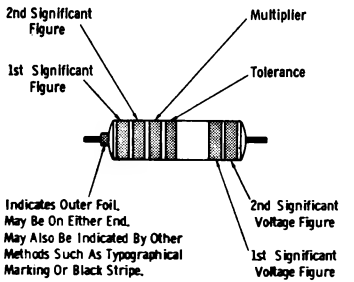
FEEDTHROUGH CERAMICS



MOLDED PAPER CAPACITOR COLOR CODE (CAPACITANCE GIVEN IN PF)

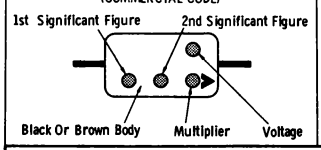
COLOR	DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	1	20%
BROWN	1	10	
RED	2	100	
ORANGE	3	1000	
YELLOW	4	10,000	
GREEN	5	100,000	5%
BLUE	6	1,000,000	
VIOLET	7		
GRAY	8		
WHITE	9		10%
GOLD			5%
SILVER			10%
NO COLOR			20%

MOLDED PAPER TUBULAR

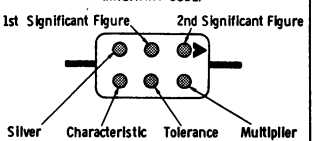

2nd Significant Figure
Multiplier
1st Significant Figure
Tolerance
Indicates Outer Foil. May Be On Either End. May Also Be Indicated By Other Methods Such As Typographical Marking Or Black Stripe.
2nd Significant Voltage Figure
1st Significant Voltage Figure

Add Two Zeros To Significant Voltage Figures. One Band Indicates Voltage Ratings Under 1000 Volts.

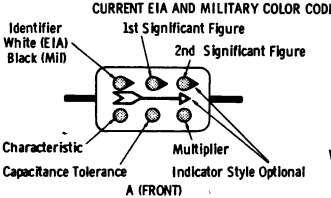
MOLDED FLAT PAPER CAPACITORS (COMMERCIAL CODE)

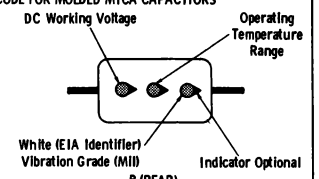


MOLDED FLAT PAPER CAPACITORS (MILITARY CODE)



CURRENT EIA AND MILITARY COLOR CODE FOR MOLDED MICA CAPACITORS





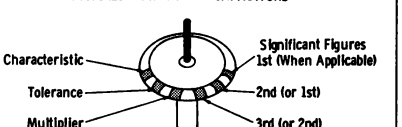
MICA CAPACITOR COLOR CODE

COLOR	CHARACTERISTIC*	CAPACITANCE 1ST AND 2ND SIGNIFICANT FIGURES	CAPACITANCE MULTIPLIER	CAPACITANCE TOLERANCE	DC WORKING VOLTAGE	OPERATING TEMPERATURE RANGE	VIBRATION GRADE (MIL)
Black	A (EIA)	0	1	±20% (EIA)		- 55° to + 70°C (MIL)	10-55 Hz
Brown	B	1	10	±1%	100 (EIA)		
Red	C	2	100	±2%		- 55° to + 85°C	
Orange	D	3	1000		300		
Yellow	E	4	10,000 (EIA)			- 55° to + 125°C	10-2000 Hz
Green	F	5		±5%	500		
Blue		6				- 55° to + 150°C (MIL)	
Purple (violet)		7					
Gray		8					
White		9					
Gold			0.1	± 1/2% (EIA)†	1000 (EIA)		
Silver			0.01 (EIA)	±10%			

* Denotes specifications of design involving Q factors, temperature coefficients, and production test requirements.
† Or ±0.5 pf, whichever is greater. All others are specified tolerance or ±1.0 pf, whichever is greater.

NOTES:
1. The multiplier is the factor by which the two significant figures are multiplied to yield the nominal capacitance.
2. "A" illustrates standard six-dot system used for "N" temperature range capacitors manufactured according to EIA Standard RS-153-A.
3. Drawings "A" and "B" combined illustrate standard nine-dot system used for "O" temperature range capacitors manufactured according to EIA Standard RS-153-A, and for all units manufactured according to Military Specification MIL-C-5C.

SILVERED MICA BUTTON CAPACITORS



SEMICONDUCTOR DIODE COLOR CODING

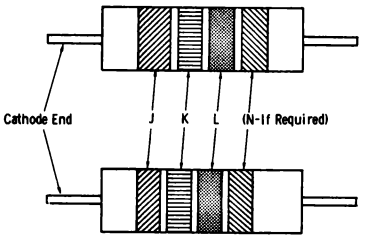
The number and letter portion following the "1N" (assigned industry type number) may be indicated by color bands.

Starting at the cathode end of the diode, bands J, K, L, and M represent the digits (For 2-digit numbers, band J is black.)

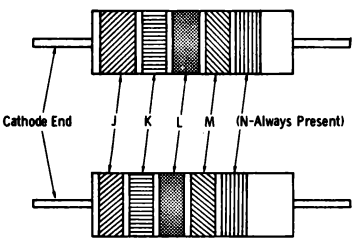
Band N designates the suffix letter A, B, C, D, E, F, G, H or J. If no letter coding is required, as in a 2- or 3-digit number, band N may be omitted. However, in a 4-digit number, band N will always be used but left black if no suffix letter is required.

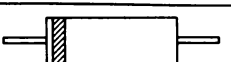
COLOR	SUFFIX LETTER	NUMBER
BLACK	–	0
BROWN	A	1
RED	B	2
ORANGE	C	3
YELLOW	D	4
GREEN	E	5
BLUE	F	6
VIOLET	G	7
GRAY	H	8
WHITE	J	9

2- OR 3- DIGIT SEQUENTIAL NUMBER



4-DIGIT SEQUENTIAL NUMBER

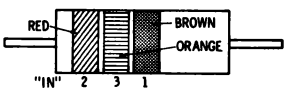


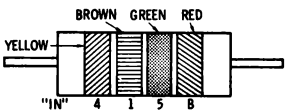


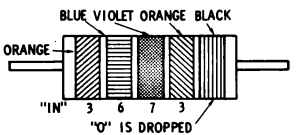
If the diode has only a single band, this indicates the cathode end of the diode.

EXAMPLES

BAND	BAND COLOR		
J	RED	YELLOW	ORANGE
K	ORANGE	BROWN	BLUE
L	BROWN	GREEN	VIOLET
M	–	–	ORANGE
N	–	RED	BLACK
	1N231	1N415B	1N3673

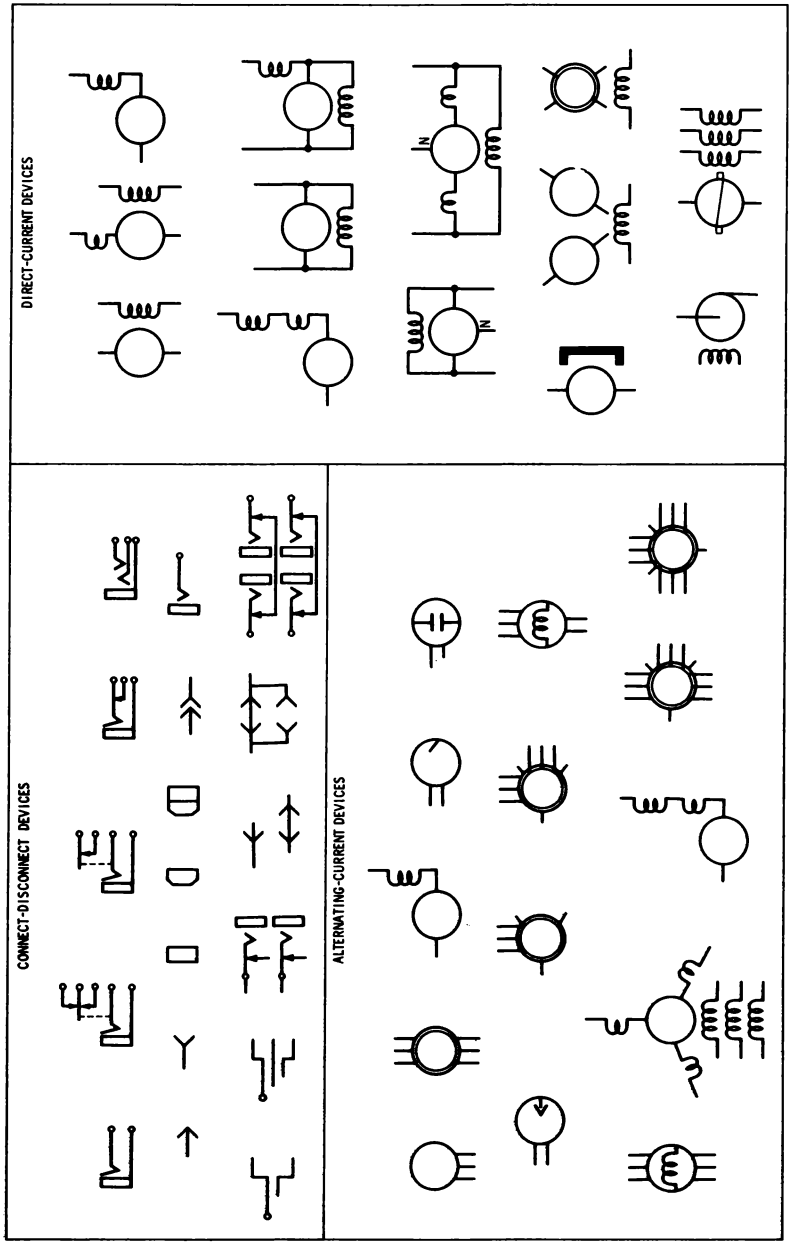




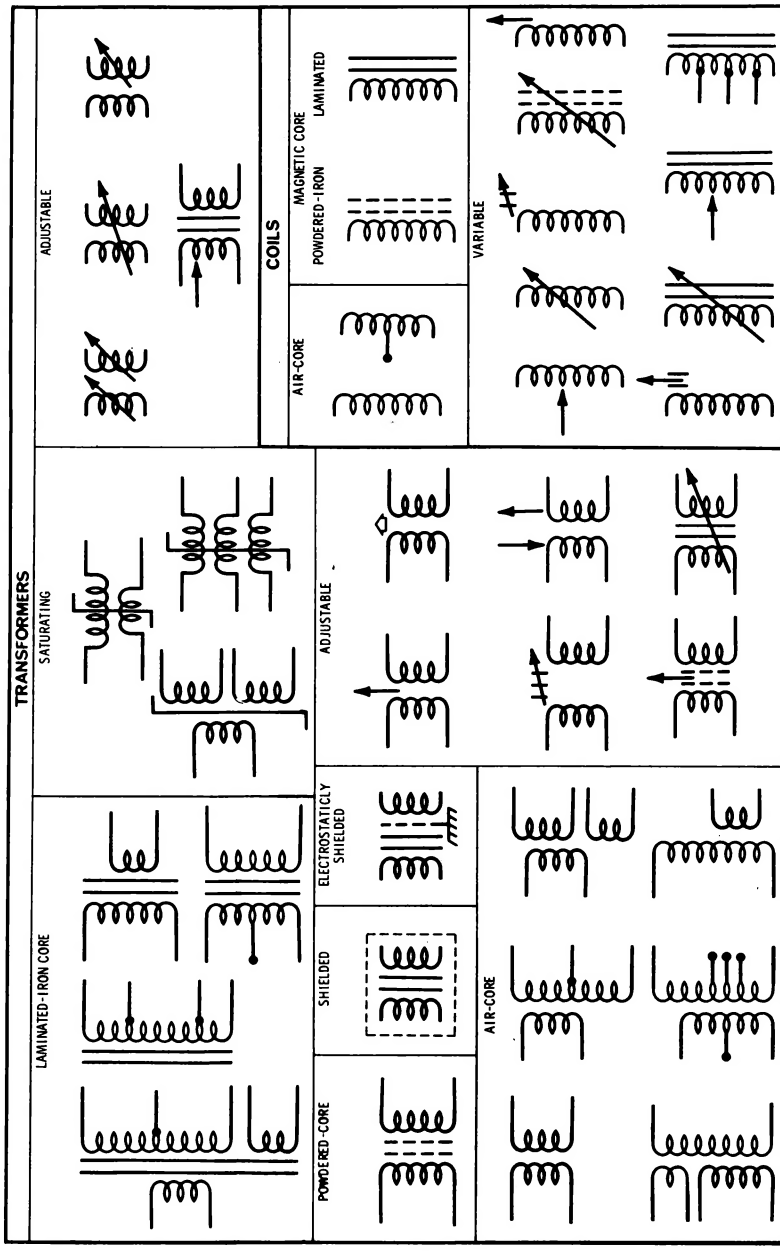


ELECTRONIC SCHEMATIC SYMBOLS

ELECTRONIC SCHEMATIC SYMBOLS—Cont



ELECTRONIC SCHEMATIC SYMBOLS—Cont



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An up-to-date DIRECT tube substitution guide. Includes more than 12,000 substitutions for all types of receiving tubes and picture tubes. Instructions accompanying each section guide the reader in making proper tube substitutions and explain how to cross-reference between sections for other substitutes.

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The first chapter contains an introduction to CB radio, covering the advent of CB and its uses. Other coverage includes obtaining a license, different types of CB radio equipment, equipment installation, antenna systems, station operation, and servicing. An appendix lists the locations of the FCC Field Offices.

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Covers basic electron theory. Discusses magnetism, electricity, and radio principles. Explains the structure and uses of resistors, capacitors, inductors, transformers, vacuum tubes, and transistors. The book concludes with several electronic experiments and construction projects.

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Explains the various uses for a tape recorder. Describes the functions of the essential parts of a recorder. Covers the advantages and disadvantages of the three types of recorders—reel-to-reel, cartridge, and cassette. Guides you in purchasing a recorder according to its specific use. Covers general maintenance of recorders, tape, and accessories.

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A listing in alphabetical order of the basic electronic components being used today. The text is supplemented with illustrations where needed for clarification. Where components can be referred to by several different names, cross-references have been included. The book is particularly helpful to newcomers to the field of electronics.

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INTRODUCTION TO SHORT-WAVE LISTENING

Contains much information on how to enjoy listening to short-wave broadcasts. It explains what short waves are, how they work, and how to receive them. Coverage is given to various receivers best suited for SWL. The type of reception received on each particular band is also given. The functions of the various controls on the receiver are explained, and information on how to use them properly is supplied.

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